Central Coast Juvenile Herring Survey, August 2004

M. Thompson and T.W. Therriault

Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
Nanaimo, British Columbia
V9T 6N7

2006

Canadian Manuscript Report of Fisheries and Aquatic Sciences 2758

Fisheries and Oceans / Pêches et Océans

Canada

Canadian Manuscript Report of Fisheries and Aquatic Sciences

Manuscript reports contain scientific and technical information that contributes to existing knowledge but which deals with national or regional problems. Distribution is restricted to institutions or individuals located in particular regions of Canada. However, no restriction is placed on subject matter, and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Manuscript reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1-900 in this series were issued as Manuscript Reports (Biological Series) of the Biological Board of Canada, and subsequent to 1937 when the name of the Board was changed by Act of Parliament, as Manuscript Reports (Biological Series) of the Fisheries Research Board of Canada. Numbers 1426 - 1550 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Manuscript Reports. The current series name was changed with report number 1551.

Manuscript reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport manuscrit canadien des sciences halieutiques et aquatiques

Les rapports manuscrits contiennent des renseignements scientifiques et techniques ques qui constituent une contribution aux connaissances actuelles, mais qui traitent de problèmes nationaux ou régionaux. La distribution en est limitée aux organismes et aux personnes de régions particulières du Canada. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports manuscrits peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports manuscrits sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annual des publications scientifiques et techniques du Ministère.

Les numéros 1 à 900 de cette série ont été publiés à titre de manuscrits (série biologique) de l'Office de biologie du Canada, et après le changement de la désignation de cet organisme par décret du Parlement, en 1937, ont été classés comme manuscrits (série biologique) de l'Office des recherches sur les pêcheries du Canada. Les numéros 901 à 1425 ont été publiés à titre de rapports manuscrits de l'Office des recherches sur les pêcheries du Canada. Les numéros 1426 à 1550 sont parus à titre de rapports manuscrits du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 1551.

Les rapports manuscrits sont produits a l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

2007-00219

Canadian Manuscript Report of

Fisheries and Aquatic Sciences 2758

2006

CENTRAL COAST JUVENILE HERRING SURVEY, AUGUST 2004

by

M. Thompson and T.W. Therriault

Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
Nanaimo, British Columbia
V9T 6N7

©Her Majesty the Queen in Right of Canada, 2006

Cat. No. 97-4/2758E ISSN 0706-6457

Correct citation for this publication:

Thompson, M., and Therriault, T.W. 2006. Central Coast juvenile herring survey, August 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2758: vii + 55 p.

TABLE OF CONTENTS

ABSTRACT vi

RESUME vii

INTRODUCTION 8

METHODS 8

RESULTS 10

CONCLUSION 12

ACKNOWLEDGMENTS 13

REFERENCES 13

LIST OF FIGURES

Figure 1. The five major British Columbia herring stock assessment regions: Prince Rupert District (PRD), Queen Charlotte Islands (QCI), Central Coast (CC), west coast Vancouver Island (WCVI) and the Strait of Georgia (SOG). 14

Figure 2. Northern Central Coast with set locations 15

Figure 3. Southern Central Coast with set locations 16

Figure 4. Northern Central Coast with CTD cast locations 17

Figure 5. Lower Central Coast with CTD cast locations 18

Figure 6. Length-frequency distribution of sampled herring. 19

Figure 7. Length-frequency distributions of sampled herring by set location 20

Figure 8. Length-weight relationship for all sampled herring (n=9351 24

Figure 9. Proportion of herring relative to catch by location 25

Figure 10. Temperature and salinity for all 27 CTD casts 26

Figure 11. Central Coast gillnet sampling areas 40

LIST OF TABLES

Table 1. Details of the 32 sets made during the 2004 Central Coast juvenile herring survey....41

Table 2. Species quantity and weights by set....42

Table 3. Percent species occurrence in all 2004 Central Coast sets....46

Table 4. Mean lengths and weights for age-0+ and age-1+ herring and total catch weight by set location....47

Table 5. Categories of organisms, by phylum, identified in plankton and stomach samples....48

Table 6. Calanoid, cyclopoid and harpacticoid copepods identified in plankton and stomach samples....49

Table 7. Zooplankton density per set in number of organisms per m^3 of water sampled.50

Table 8. Herring stomach fullness (%) and state of digestion (%)....53

Table 9. Quantity and percent occurrence of identifiable prey items in age-0+ herring stomachs (N) by location....54

Table 10. Quantity and percent occurrence of identifiable prey items in age-1+ herring stomachs (N) by location....56

Table 11. Herring predator stomach contents from gillnet caught fish....58

Table 12. Herring predator stomach contents from purse seine caught fish....61

ABSTRACT

Thompson, M., and Therriault, T.W. 2006. Central Coast juvenile herring survey, August 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2758: vii + 55 p.

In 2004, a Central Coast juvenile herring survey was conducted from August 9-21. Thirty-two sets were made at 12 locations within Statistical Management Areas 6, 7, 8 and 9. The study area extended from Meyers Passage in the north to Fish Egg Inlet in the south. The survey serves to address information gaps on the distribution, abundance, size and feeding habits of juvenile herring in these nearshore, northern areas.

Eighteen species of fish were identified in the purse seine catches with herring being the most frequently encountered species. A total of 9351 herring were measured resulting in a length frequency distribution that was distinctly bimodal representing age-0+ and age-1+ fish. Age-0+, age-1+ and age-2+ or older herring occurred in 96.9%, 71.9% and 15.6% of the sets, respectively. A total of 250 herring stomachs and 124 potential herring predator stomachs were analysed for stomach content. Twenty-one oblique plankton tows were performed during the survey. Unidentifiable juvenile calanoid copepods and *Acartia longimeres* were the most prominent zooplankters. Twenty-seven CTD casts were performed during the survey to document oceanographic conditions.

RESUME

Thompson, M., and Therriault, T.W. 2006. Central Coast juvenile herring survey, August 2004. Can. Manuscr. Rep. Fish. Aquat. Sci. 2758: vii + 55 p.

En 2004, une campagne de recensement portant sur les stocks de harengs juvéniles de la partie centrale de la côte a été effectuée entre le 9 et le 21 août. Au total, 32 traits de senne ont été effectués à 12 endroits différents des zones de gestion statistiques 6, 7, 8 et 9. Le secteur couvert s'étendait du passage Meyers (nord) au passage Fish Egg (sud). Cette campagne de recensement permettra d'avoir des données plus complètes sur la distribution, l'abondance, la taille et les habitudes alimentaires des harengs juvéniles dans ces zones du littoral nord.

En tout, 18 espèces de poissons ont été dénombrées dans les ponctions effectuées, le hareng étant l'espèce la plus souvent représentée, et 9 351 harengs ont été mesurés. Les résultats indiquent une distribution nettement bimodale de la fréquence des longueurs, représentant la prédominance de la cohorte 0+ et de la cohorte 1+. Les harengs des classes d'âge 0+, 1+ et 2+ et plus étaient présents à des taux de 96,9 %, 71,9 % et 15,6 % respectivement. De plus, 250 contenus stomacaux de harengs et 124 contenus stomacaux de prédateurs de harengs ont été analysés, et 21 traits obliques de filets à plancton ont été effectués lors de cette campagne. Les copépodes calanoïdes juvéniles (non identifiables) et les *Acartia longimeres* étaient les espèces de zooplancton dominantes. Enfin, 27 sondages de CTP ont été effectués en concomitance avec les opérations de recensement, pour documenter les conditions océanographiques.

INTRODUCTION

Pacific herring (*Clupea pallasi*) are an important commercial species and a vital forage species for many marine mammals, birds and other fish in British Columbia's coastal waters. Herring spawn principally on marine vegetation in the subtidal and upper intertidal zone between February and June, with peak spawning between March and April (Humphreys and Hourston 1978). Larvae hatch in two to three weeks, and disperse with surface currents, metamorphosing into juvenile herring at a length of ~25mm (Hourston and Haegele 1980). Herring are considered juvenile until they are three years of age and have joined the sexually mature spawning population (Hay and McCarter 1999). During daylight hours, juvenile herring congregate in schools, occasionally forming mixed aggregates with other pelagic species, close to shore near the bottom (Haegele 1997). At dusk, these fish migrate into surface waters to feed on plankton. During this time they are vulnerable to purse seine gear.

Relatively little is known about the distribution, abundance, size and feeding habits of juvenile herring in the Central Coast of British Columbia (Figure 1). In 2002 and 2003, juvenile herring surveys were designed to address information gaps and learn about the general biology of herring in this geographical area. The survey used an ecosystem based approach to biological sampling. Therefore, in addition to juvenile herring, all other fish species were retained for analyses. In addition, plankton samples, oceanographic data and predator stomach samples were collected. Juvenile herring stomach contents also were examined from six set locations. This approach will potentially provide a better understanding of the role and relationships juvenile herring have in Central Coast waters, and may provide an empirical forecast of recruitment to the herring roe fishery based on relative juvenile abundance.

METHODS

In 2004, the Central Coast juvenile herring survey was conducted from August 9-21. Thirty-two sets were made at 12 locations within Statistical Management Areas 6, 7, 8 and 9 (Table 1). The study area extended from Meyers Passage in the north to Fish Egg Inlet in the south (Figures 2 and 3). The 2004 set locations were nearly identical to set locations used in previous years (Henderson et al. 2004, 2005). The sampling sites originally were chosen based on known historical herring spawning sites, and represent both nearshore and open water habitats (Haegele and Armstrong 2003).

Fish Sampling

The 12m, aluminium-hulled Fisheries Research Vessel *Walker Rock* was used for all fishing events. A 183m long and 27m deep purse seine net of knotless web, resulting in an area fished of ~2665m^2, was used for all fishing events. The body of the net had 46m of 22.2mm mesh at the tow end followed by 91m of 19.0mm mesh, and the bunt end was 46m of 9.5mm mesh. The net fished to a depth of 10m, and was able to retain fish

greater than 20mm in length. All sets were made after dusk when herring are feeding near the surface. All sets were made "blind" at predetermined set locations. Up to four sets were completed per night, depending on location. No proposed sets were lost due to adverse weather or oceanic (tide) conditions. For most sets, it was possible to land the entire catch for biological sampling. On occasion, it was not practical to land a large set in its entirety, so sub-sampling was necessary. When sub-sampling was required, a 40kg tote was filled with randomly selected fish and retained for biological sampling. Several dipnet samples from various parts of the net (catch) would be used to make up the random sub-sample. The remainder of the set was released over the corkline, its size estimated as the number of totes released. The number of herring caught in each set was determined by dividing the total catch weight by the mean weight of sub-sampled herring. The number of other species caught was determined in the same manner (Table 2). All fish retained for sampling were weighed, bagged and preserved in a 3.7% seawater formalin solution, with the exception of large predator species (e.g., adult salmon, dogfish and mackerel). These fish were individually weighed and measured in the field, and their stomachs were removed and preserved for later analysis under laboratory conditions at the Pacific Biological Station. A second method of predator capture employed two gillnets, a 121.9m (400ft) 11.4cm (4.5inch) mesh and a 106.7m (350ft) 15.6cm (6.125inch) mesh. Soak times varied from one half hour to one hour for gillnets. All gillnet captured fish were measured and weighed in the field and stomachs removed for later analysis using the methods outlined above.

From each set, 200 or more herring and all other fish species caught were identified, weighed and measured. If the set contained less than 200 herring, then all herring were weighed and measured. Consistent with standard practices, herring were measured to standard length; salmon to fork length; dogfish, hake and pollock to total length. All other fish species were measured to standard length. Herring from six selected sets were retained for stomach content analysis, 100 age-0+ and 150 age-1+ herring.

Plankton Sampling

Twenty-one stepped oblique plankton tows were performed during the survey. The tows always were completed after dusk and immediately before or after a fishing event. Dual 19cm diameter bongo nets with 350μm mesh were used for sampling, resulting in 'left' and 'right' bongo plankton samples (only left samples were processed). The bongos were lowered to 20m (10m in shallow areas) and raised by an electric winch at a rate of 1m every 15sec (or 1m every 30sec for shallow areas). A General Oceanics® 2030R model flowmeter was attached to the left bongo to determine the volume of seawater filtered. Volume filtered was calculated using the following equation (McCarter and Hay 2002):

$$V = (A \cdot F \cdot K) / 999{,}999 \qquad \textbf{Equation 1}$$

Where:

V = volume of water filtered through the plankton net (m^3)
A = area of net opening ($0.02835 m^2$)
F = number of revolutions recorded by the flow meter (m)
K = standard speed rotor constant for 7cm rotor (26,873)

Upon retrieval, the bongo nets were washed with a high pressure deck hose, and the samples preserved in 3.7% seawater formalin.

In the laboratory, a volumetric splitter was used to reduce the sample size to a point where organisms could be conveniently counted and identified in a counting tray using a stereo microscope under 30X magnification. Sample splitting continued until a target size of roughly 300 organisms was reached (Thompson et al. 2003).

When possible, plankters were identified to the lowest taxonomic level. Copepods were identified to species. Densities for all plankters were determined and expressed as plankters $\cdot m^{-3}$.

CTD Sampling

To characterize oceanographic conditions in the surveyed area, a total of 27 CTD (conductivity – temperature – density) casts were made using a Sea-bird model 16plus (Figures 4 and 5). A CTD cast was performed at each set location. The CTD unit was weighted and lowered over the side of the vessel to a depth of 30m. A winch was used to return the CTD at a rate of 1m/sec. Data was downloaded to a laptop computer from the CTD unit after each cast.

RESULTS

Thirty-two sets were made during the 2004 survey; three in section 091 (Fish Egg Inlet), three in section 085 (Kwakshua Channel), five in section 076 (Kildidt Sound and Spider Anchorage), three in section 074 (Thompson Bay), five in section 067 (Kitasu Bay and Meyers Passage), three in section 077 (East Higgins Pass), five in section 072 (Powell Anchorage and Spiller Channel), three in section 073 (Hunter Channel) and two in section 084 (Burke Channel). All 2004 set locations correspond to set locations used in the 2002 and 2003 Central Coast surveys (Figures 2 and 3, Table 1).

Eighteen species of fish and two invertebrate species were identified in the seine catches. The most frequently encountered species (>15% occurrence) included: Pacific herring, walleye pollock, spiny dogfish, whitebait smelt, three-spine stickleback, opal squid, and jellyfish (Tables 2 and 3).

Herring

A total of 9351 herring were measured resulting in a length frequency distribution that was distinctly bimodal. Based on this length frequency distribution (Figure 6), the length designations for the two juvenile herring age-classes are:

0+ = herring less than or equal to 93mm standard length

1+ = herring between 94mm and 146mm standard length
2+ and old r = herring greater than or equal to 147mm standard length

Figure 6 and Figure 7 Spiller Channel histograms show a small mode of age-0+ herring ranging in size from 50 to 60mm. It is probable that these smaller-than-average herring were a result of a late spawning occurrence in this area.

Age-0+ herring occurred in 96.9% of the sets (Table 3). Age-0+ herring were caught in every set except for set 13 (Thompson Bay). Table 4 shows the average length and weight for age-0+ herring, and the total herring catch weight at each set location. The mean length of all sampled age-0+ herring (n=8111) was 72.3mm.

Age-1+ herring occurred in 71.9% of the sets (Table 3). Table 4 shows the average length and weight for age-1+ herring, and the total herring catch weight at each set location. The mean length of all sampled age-1+ herring (n=1235) was 113.6mm.

Age-2+ herring occurred in 15.6% of the sets (Table 3). The mean length of all sampled age-2+ herring (n=5) was 155.8mm.

Herring length-frequency distributions varied by location. The histograms display the length frequency for sampled herring only (Figure 7) but provide a representation of juvenile herring length distribution during the survey. The relationship between length and weight for all sampled herring was determined by fitting a logistic function to the length-weight data (Figure 8). Spiller Channel and Kitasu Bay resulted in the least amount of herring caught in relation to total catch while Thompson Bay and Hunter Channel resulted in the highest proportion of herring caught (Figure 9).

Plankton

There were 27 categories of organisms identified in 21 plankton samples (Tables 5 and 6). An average of 14.62m^3 of water was filtered per plankton tow. Copepods occurred in all samples. Unidentifiable juvenile calanoid copepods and *Acartia longimeres* were the only organisms to occur in all samples. Amphipods, cladocerans, coelenterates, crab megalopea and zoea, ctenophores, larval euphausiids, larvaceans (*Oikopleura sp.* and *Fritillaria sp.*), shrimp larvae and calanoid copepods (*Acartia longiremis*, and *Centropages abdominals*), and unidentifiable juvenile calanoid copepods made up >75% of samples. Barnacle nauplii, ectoprocts, miscellaneous eggs (mostly fish or euphausiids), polychaetes, siphonophores and the calanoid copepods *Metridia pseudopacifica*, *Pseaudocalanus minutus*, and *Paracalanus parvus* occurred in 50 – 74% of samples. Chaetognaths, adult euphausiids, gastropods, cyclopoid copepod *Oithona sp.* and calanoid copepods (*Calanus marshallae* and *Calanus pacificus*) occurred in 25 – 49% of samples. Barnacles, unidentified copepod nauplii, copepods, echinoderms, euphausiids, fish larvae, crustacean nauplii, ostracods, pelecypods, pteropods, squid larvae, cyclopoid copepod (*Corycaeus anglicus*) and calanoid copepods (*Acartia clausi*, *Canadacia columbiae*, *Eucalanus bungii*, *Eucalanus elongates*, *Epilabidocera*

longipedata, Pseudocalanus sp., and *Tortanus discaudatus*) in <25% of samples (Table 7).

CTD

A CTD cast was performed at each set location. Data from five casts were lost due to equipment problems. The CTD provided a range of data for temperature (°C), salinity (ppt) and depth (m) (Figure 10).

Herring Stomach Contents

A total of 165 age 0+ herring stomachs were examined (Table 8). Of these, 143 contained identifiable stomach contents. On average, barnacle cyprids, barnacle nauplii, *Podon sp.* and *Evadne sp.* cladocerans, and *Corycaeus anglicus* occurred the most frequently (Table 9).

A total of 85 age-1+ herring stomachs were examined (Table 8). Of these, 79 contained identifiable stomach contents. On average, unidentifiable calanoid copepods, barnacle cyprids, barnacle nauplii, *Podon sp.* and *Evadne sp.* cladocerans, and crab zoea occurred the most frequently (Table 10).

Other Species Stomachs

Chinook, coho, pink and sockeye salmon, spiny dogfish shark, and Pacific hake were sampled. A total of 124 possible herring predator stomachs were sampled, with only 11 stomachs containing identifiable herring. Eighty-one stomachs were taken from gillnet samples (Figure 11 and Table 11) and 43 stomachs were taken from the purse seine samples (Table 12). Several stomachs had material that was unidentifiable fish, so only the stomach content weight was recorded. Two salmon species (chinook and coho) were found to contain juvenile herring (age-0+ and age-1+).

CONCLUSION

Thirty-two stations were sampled resulting in 18 different fish species recorded from the purse seine sets. A total of 9351 herring were measured and weighed creating a distinct bimodal histogram representing two juvenile herring age groups. A total of 224 herring stomachs were examined for contents. The dominant prey item was calanoid copepods for age 0+ herring and crab zoea for age 1+ herring. A total of 124 possible herring predator stomachs were sampled, with only 11 stomachs containing identifiable herring. Twenty-one plankton tows were performed resulting in unidentifiable juvenile calanoid copepods and *Pseudocalanus minutus* being the most prominent organisms.

ACKNOWLEDGMENTS

This study was funded by the Herring Conservation and Research Society (HCRS), and we are grateful for their continuing support. All plankton and herring stomach samples were processed by Carol Cooper of Zotec Services. Bob Armstrong of Armstrong Biotech Services, Dennis Chalmers and Christa Hrabok conducted the field work. Fisheries and Oceans provided the research vessel and laboratory facilities.

REFERENCES

Haegele, C.W. 1997. The occurrence, abundance and food of juvenile herring and salmon in the Strait of Georgia, British Columbia in 1990 to 1994. Can. Manuscr. Rep. Fish. Aquat. Sci. 2390: 124 p.

Haegele, C.W., and Armstrong, R.W. 2003. Juvenile herring survey of the Central Coast of British Columbia, August 11-24, 2002. Contractors report for the Herring Conservation and Research Society: 34 p.

Hay, D.E., and McCarter, P.B. 1999. Age of sexual maturation and recruitment in Pacific herring. Can. Sci. Advis. Sec. Res. Doc. 99/175: 42 p.

Henderson, S., Therriault, T.W., Haegele, C.W., Schweigert, J., and Thompson, M. 2004. Central Coast Juvenile Herring Survey, August 2002. Can. Manuscr. Rep. Fish. Aquat. Sci. 2687: 33 p.

Henderson, S., Thompson, M., and Therriault, T.W. 2005. Central Coast Juvenile Herring Survey, August 2003. Can. Manuscr. Rep. Fish. Aquat. Sci. 2710: v + 36 p.

Hourston, A.S., and Haegele, C.W. 1980. Herring on Canada's Pacific coast. Can. Spec. Publ. Fish. Aquat. Sci. 48: 23 p.

Humphreys, R.D., and Hourston, A.S. 1978. British Columbia herring spawn deposition survey manual. Fish. Mar. Serv. Misc. Spec. Publ. 38: 40 p.

McCarter, P.B., and Hay, D.E. 2002. Eulachon embryonic egg and larval outdrift sampling manual for ocean and river surveys. Can. Tech. Rep. Fish. Aquat. Sci. 2451: 33 p.

Thompson, M., Hrabok, C., Hay, D.E., Schweigert, J., Haegele, C., and Armstrong, B. 2003. Juvenile herring surveys: methods and data base. Can. Manuscr. Rep. Fish. Aquat. Sci. 2651: 31 p.

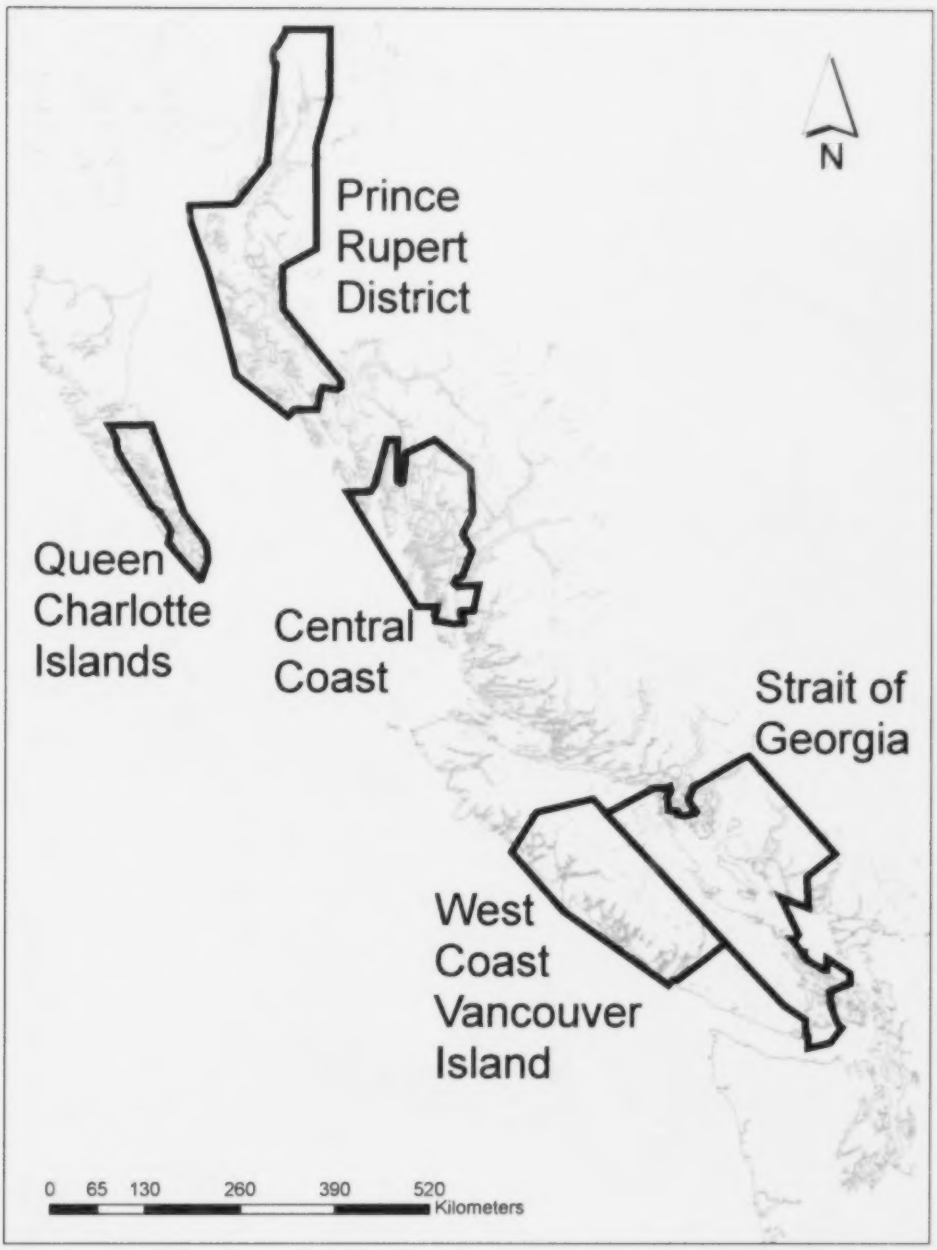


Figure 1. The five major British Columbia herring stock assessment regions: Prince Rupert District (PRD), Queen Charlotte Islands (QCI), Central Coast (CC), west coast Vancouver Island (WCVI) and the Strait of Georgia (SOG).

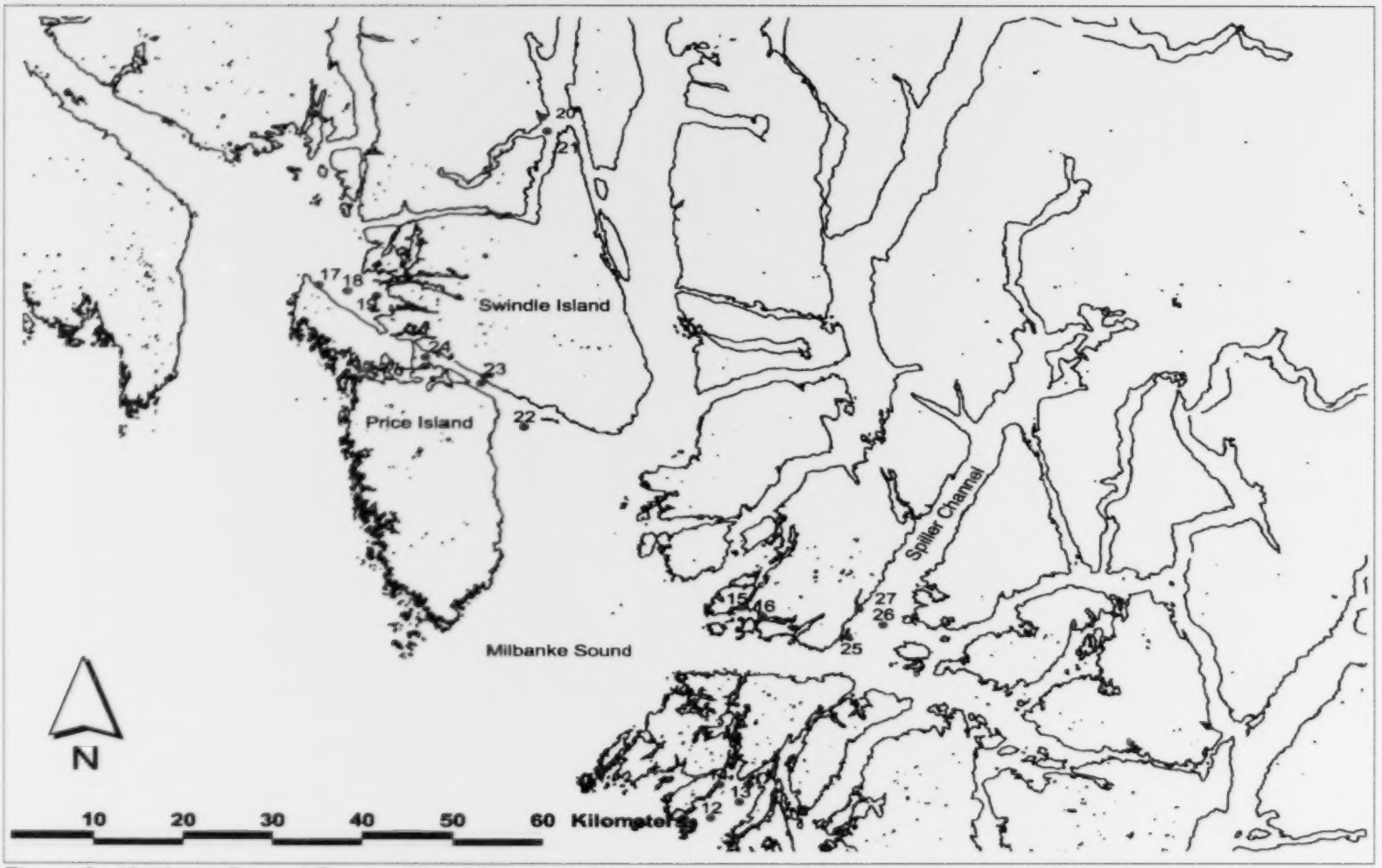


Figure 2. Northern Central Coast with set locations.

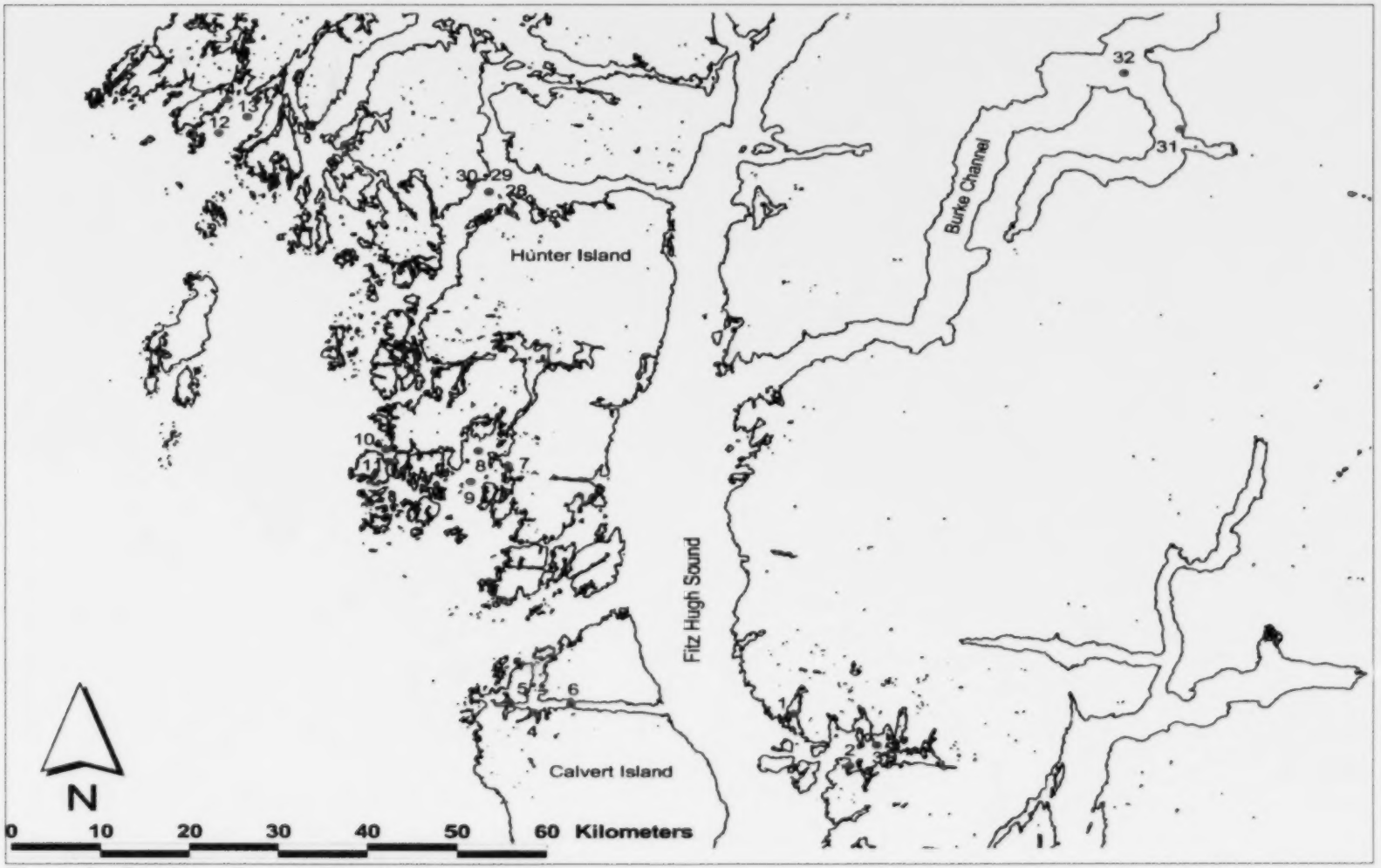


Figure 3. Southern Central Coast with set locations.

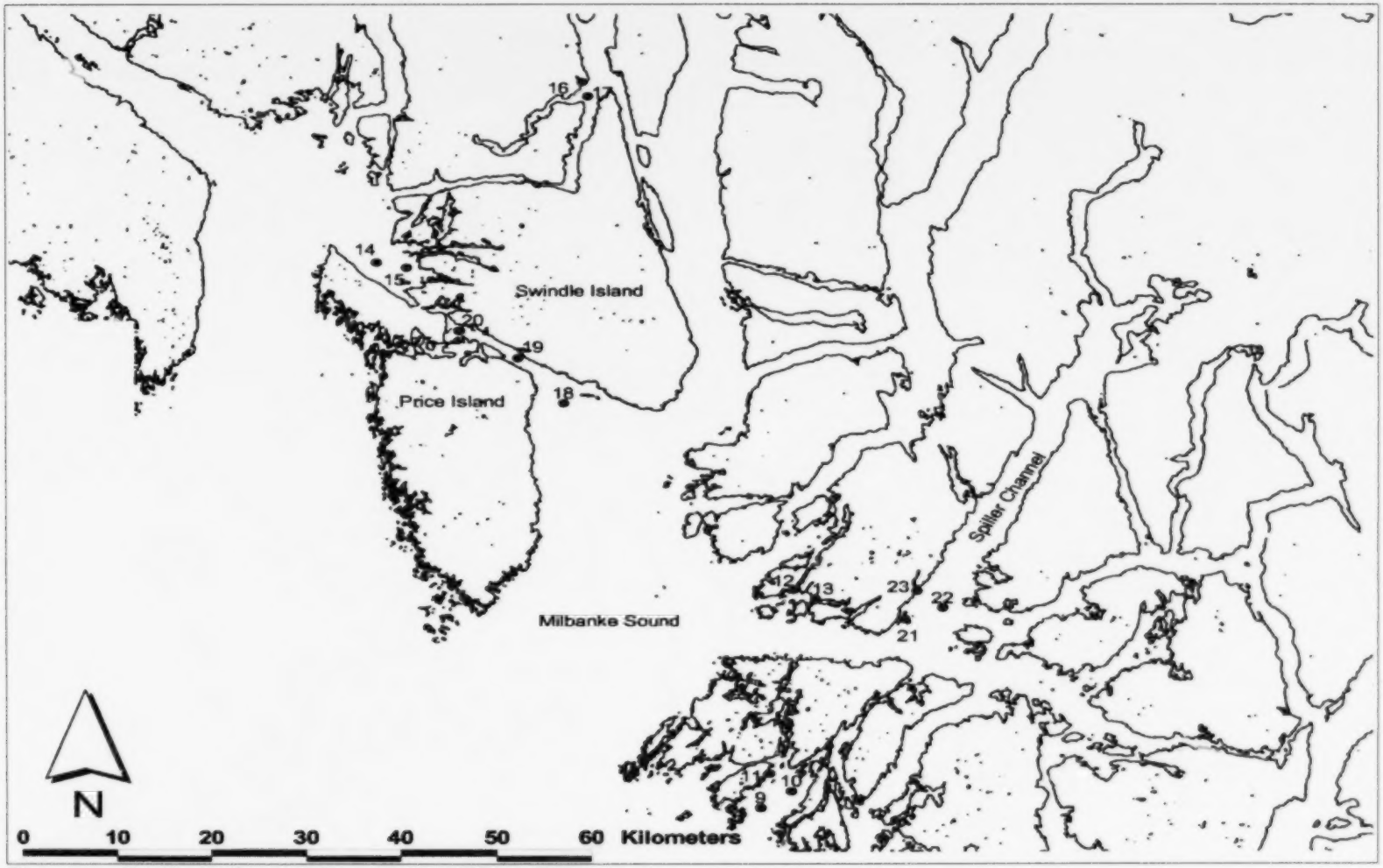


Figure 4. Northern Central Coast with CTD cast locations.

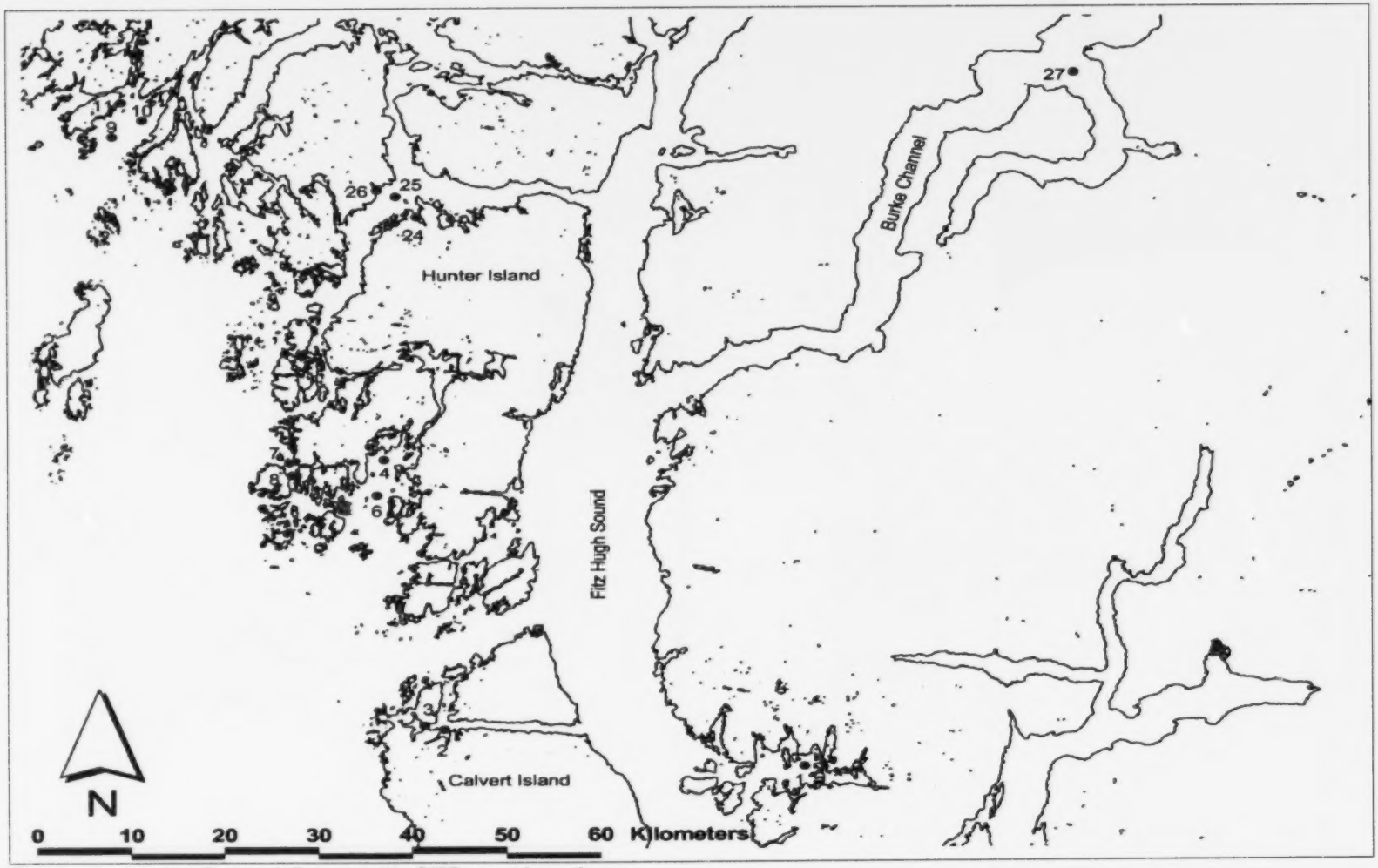


Figure 5. Lower Central Coast with CTD cast locations.

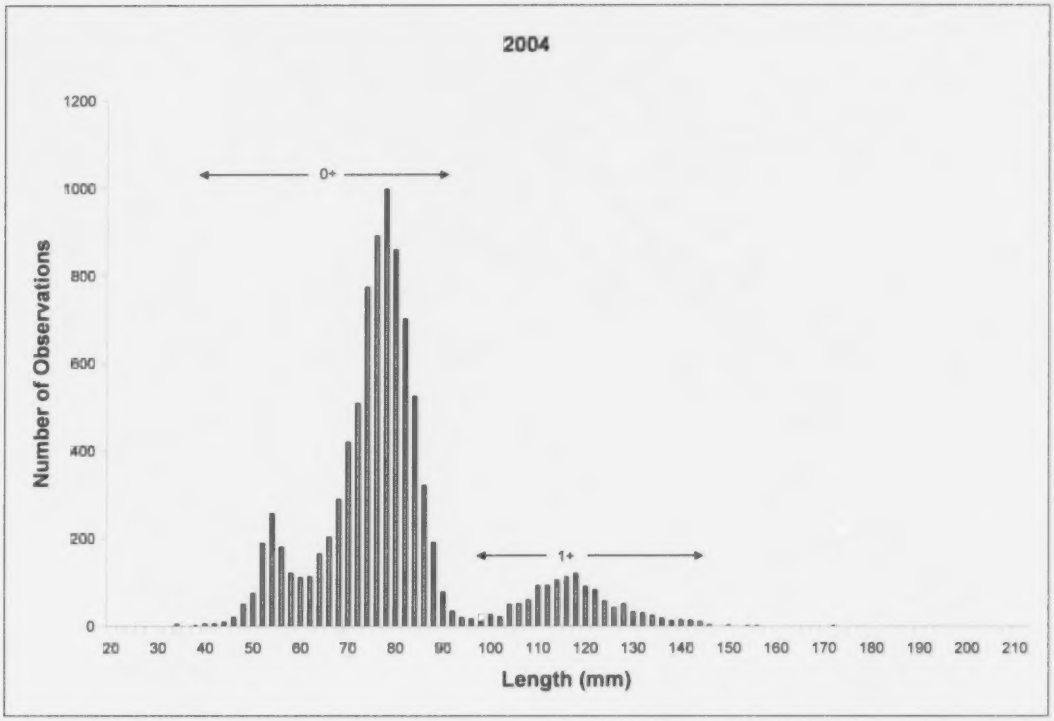


Figure 6. Length-frequency distribution of sampled herring (n=9351).

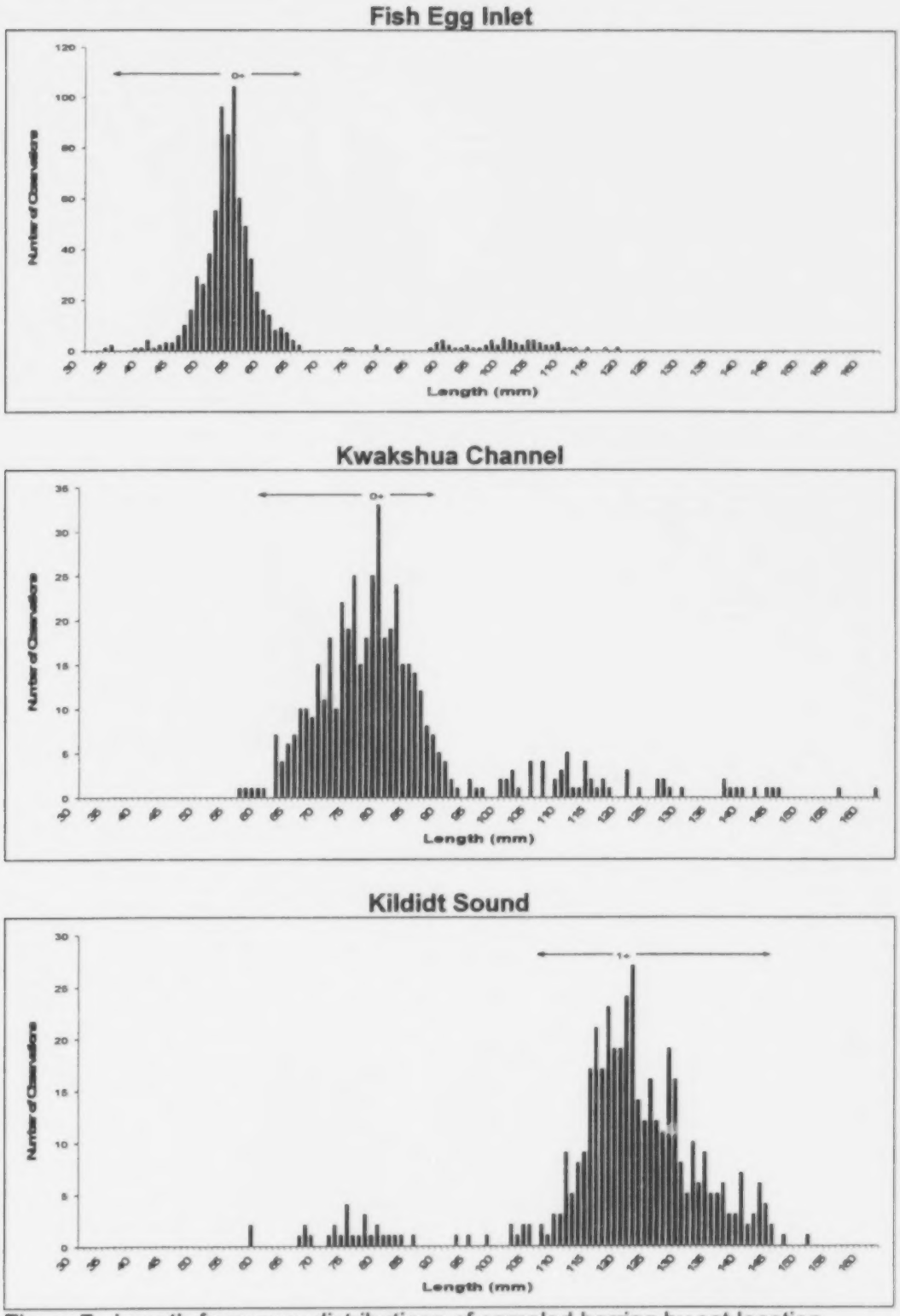
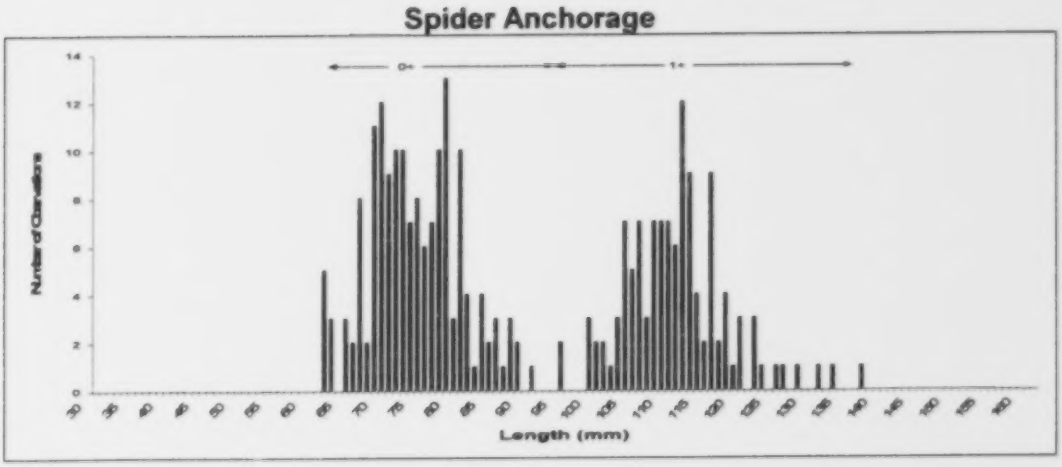
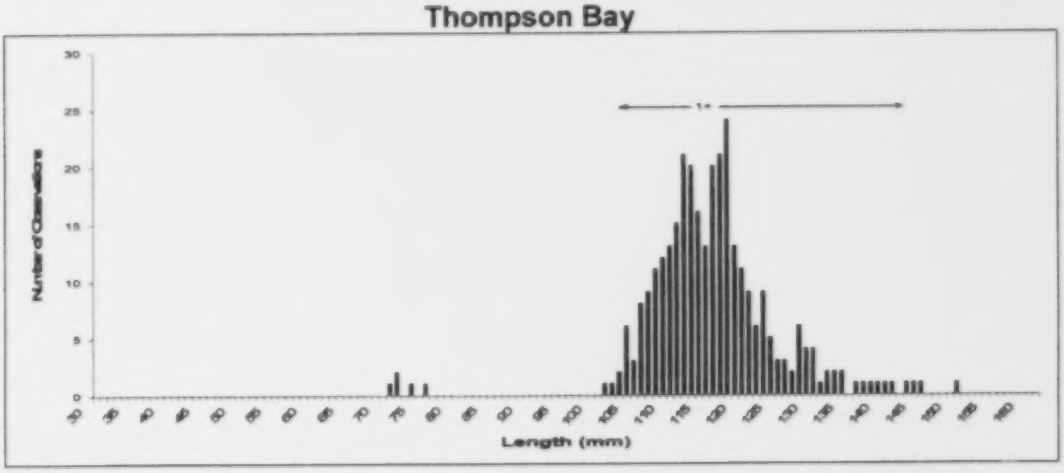


Figure 7. Length-frequency distributions of sampled herring by set location.





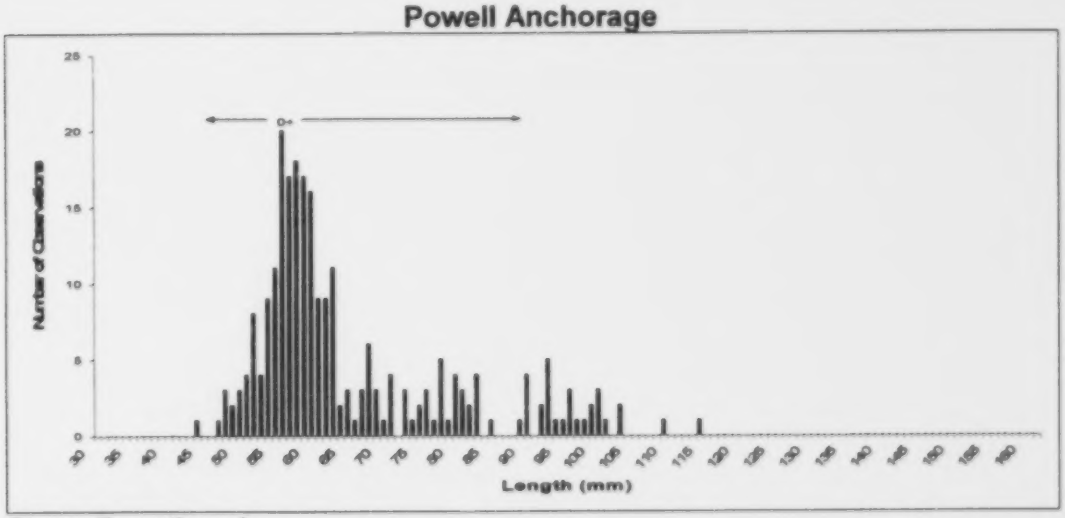
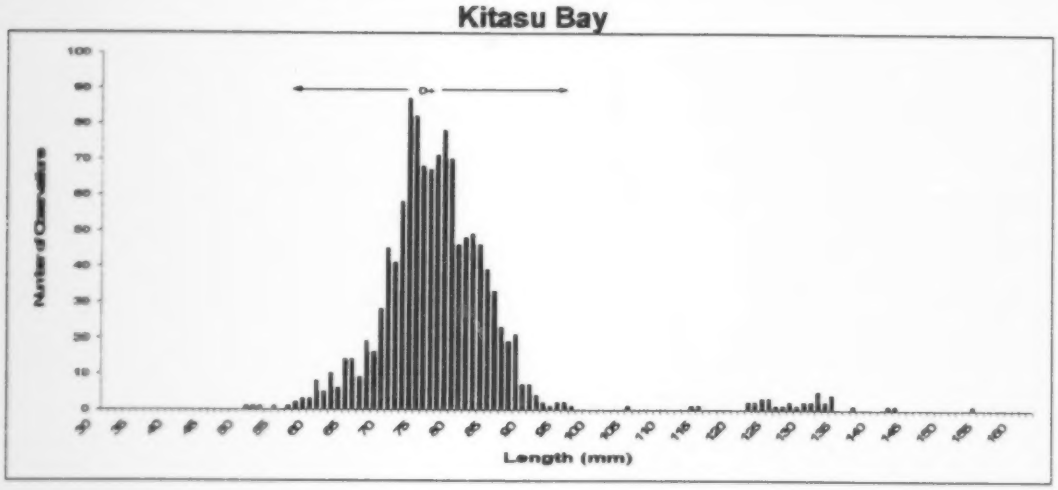
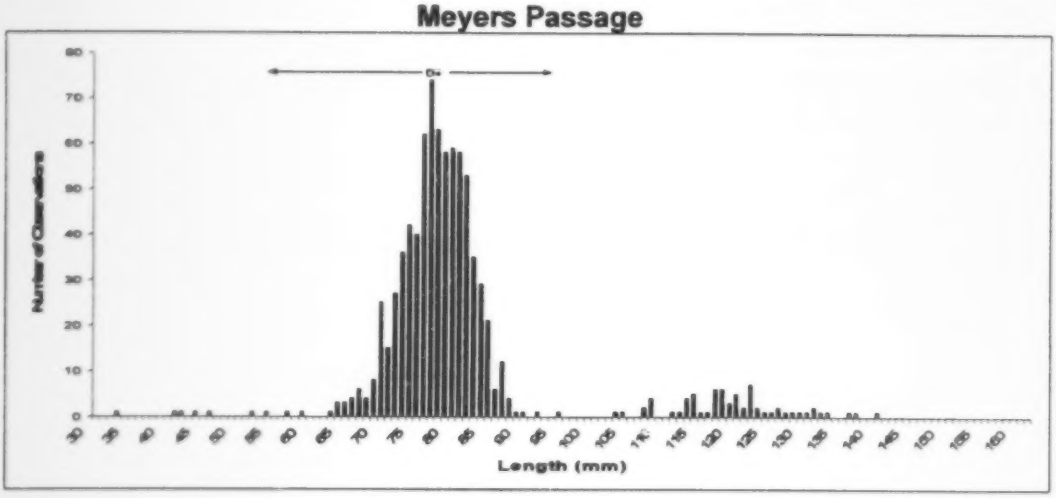


Figure 7 continued...





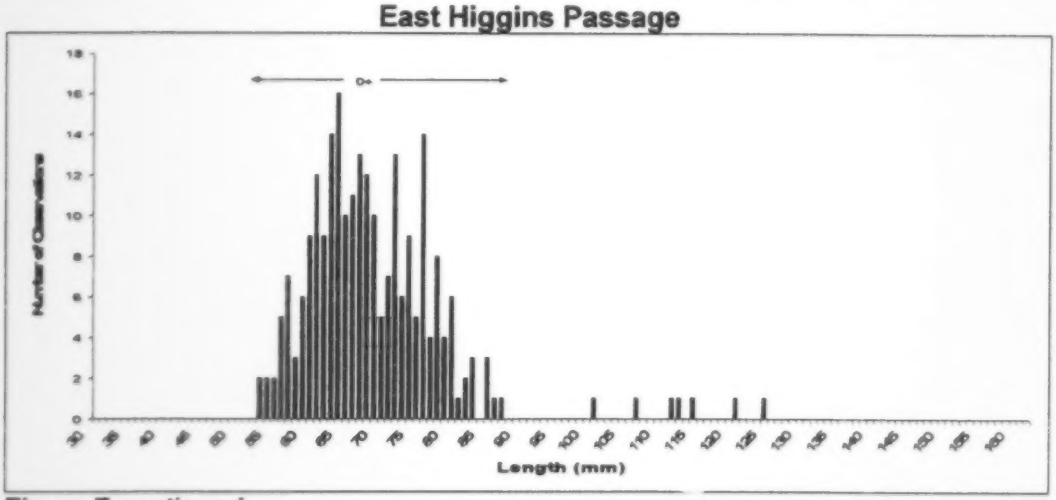
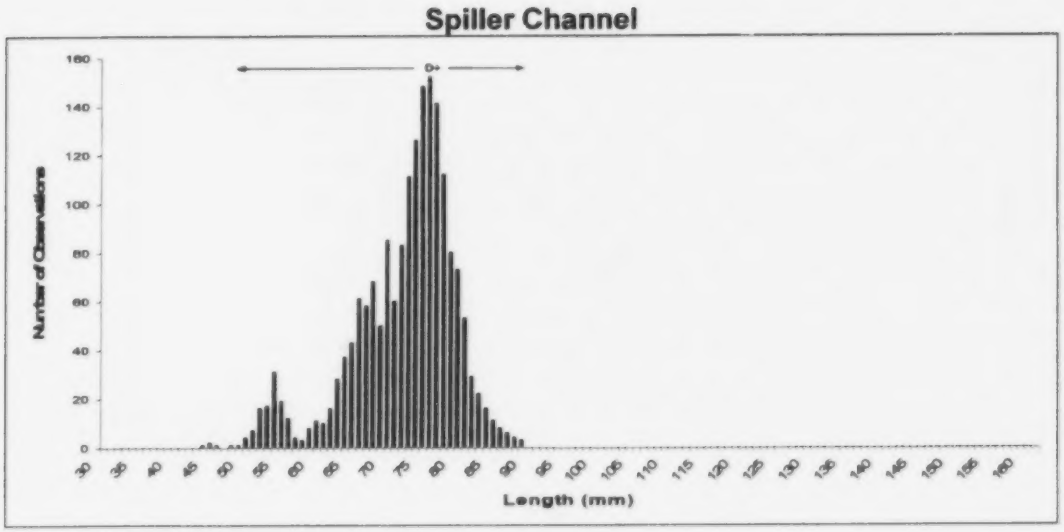
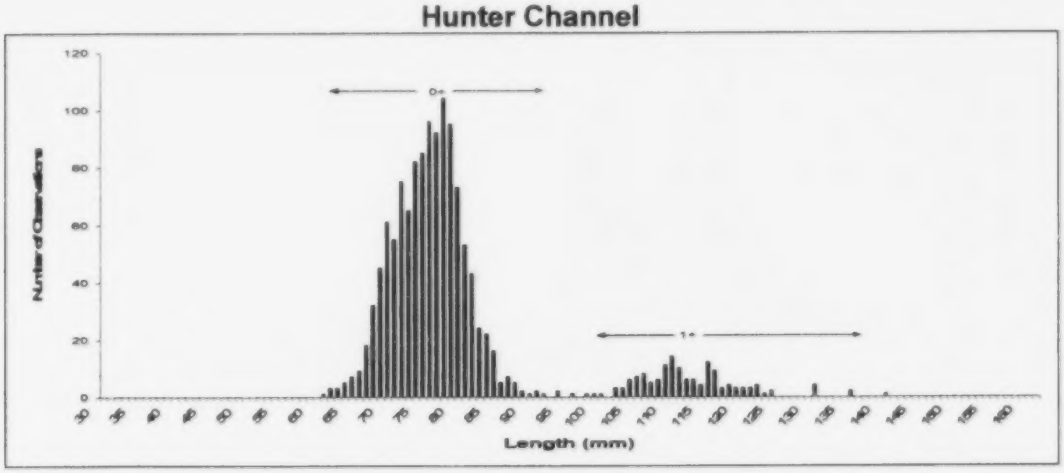


Figure 7 continued...





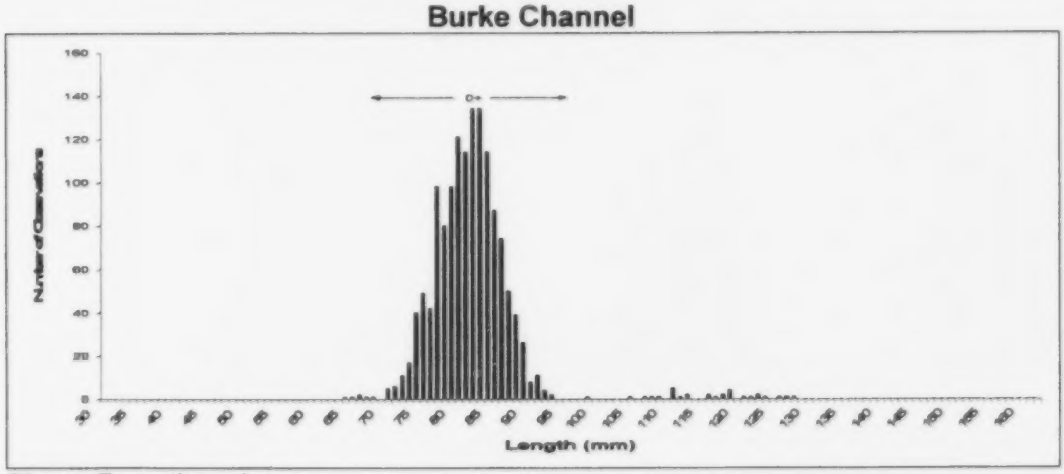


Figure 7 continued...

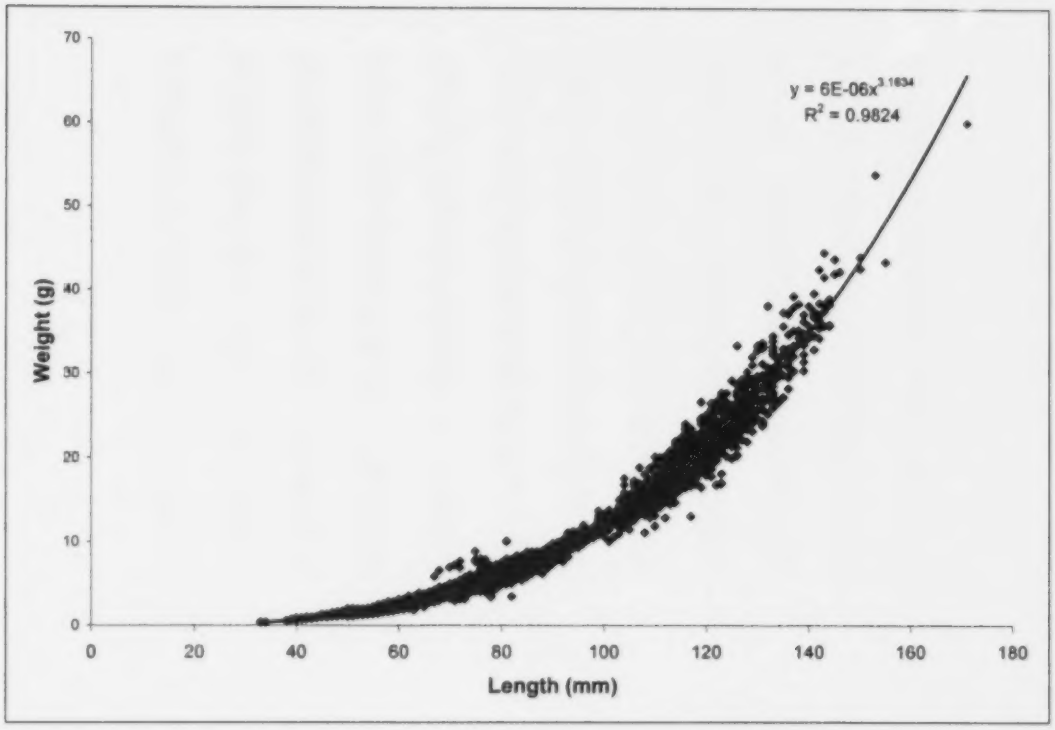


Figure 8. Length-weight relationship for all sampled herring (n=9351).

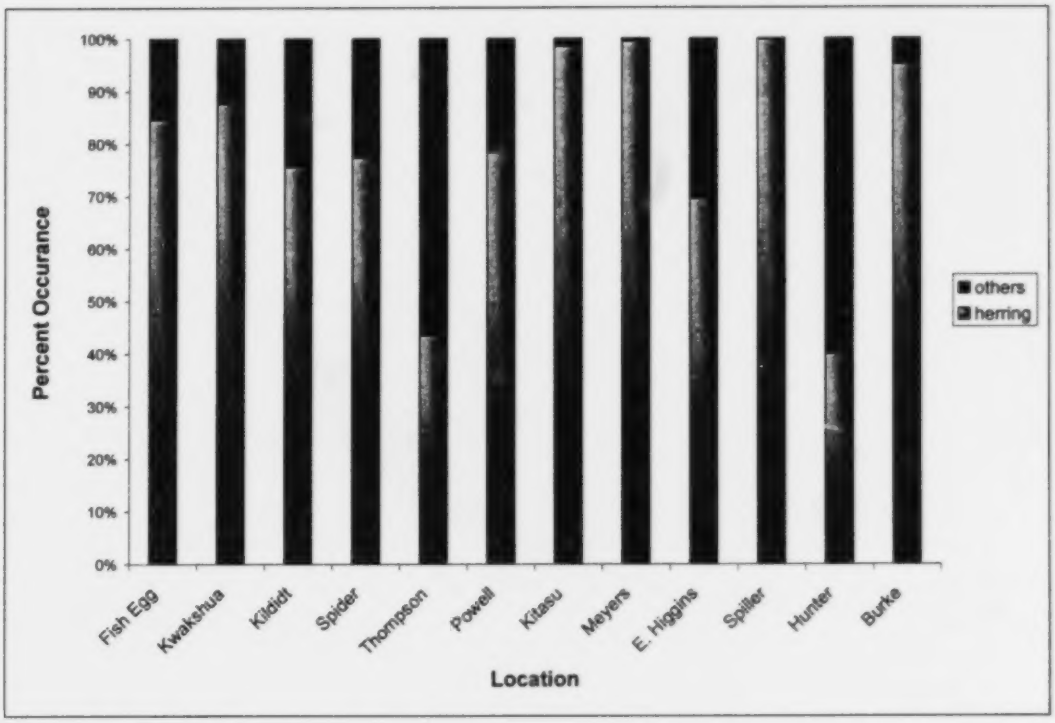
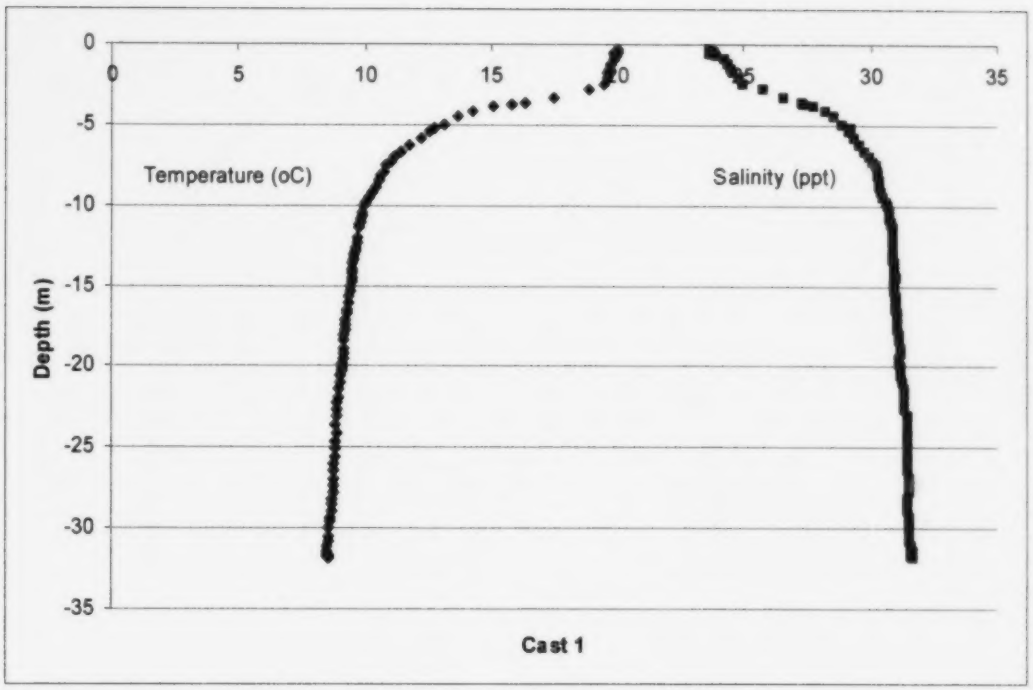


Figure 9. Proportion of herring relative to catch by location.



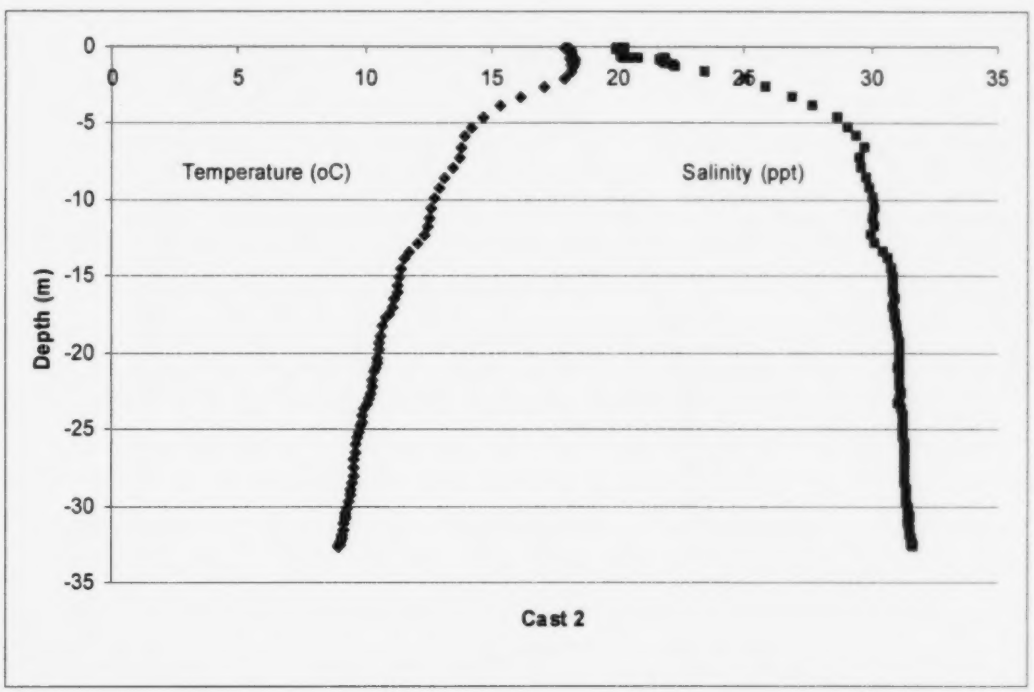
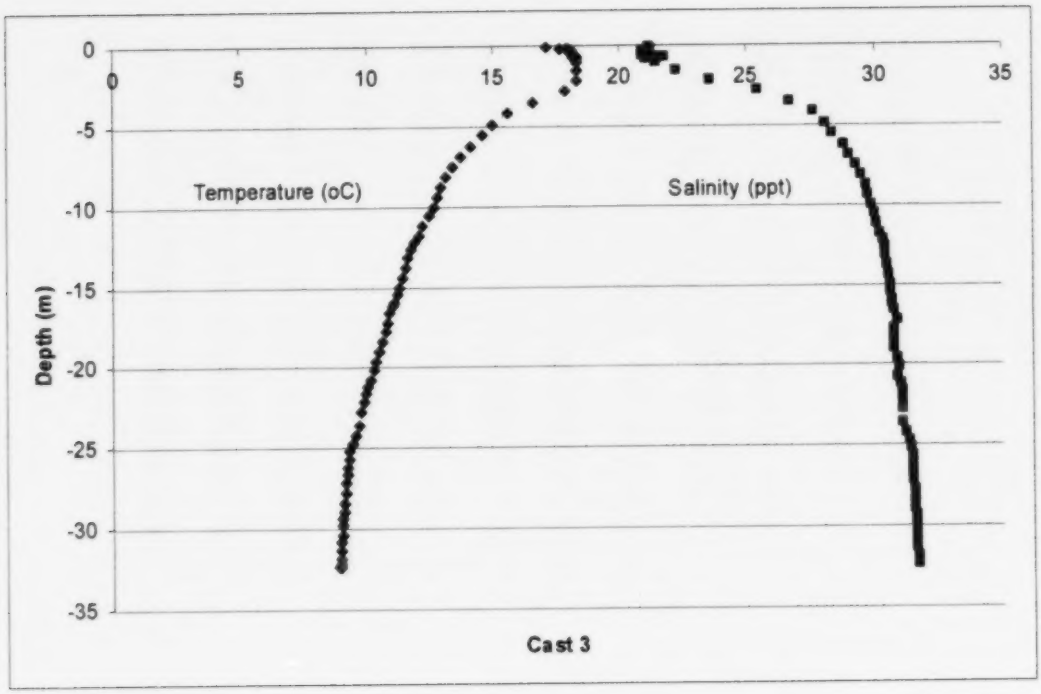


Figure 10. Temperature and salinity for all 27 CTD casts.



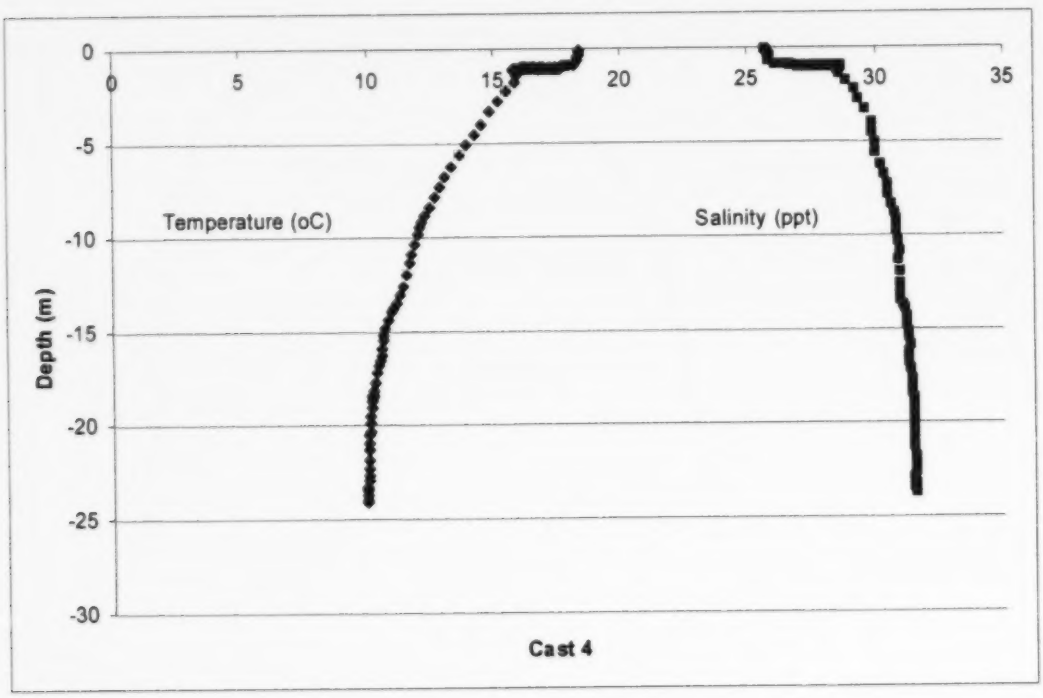
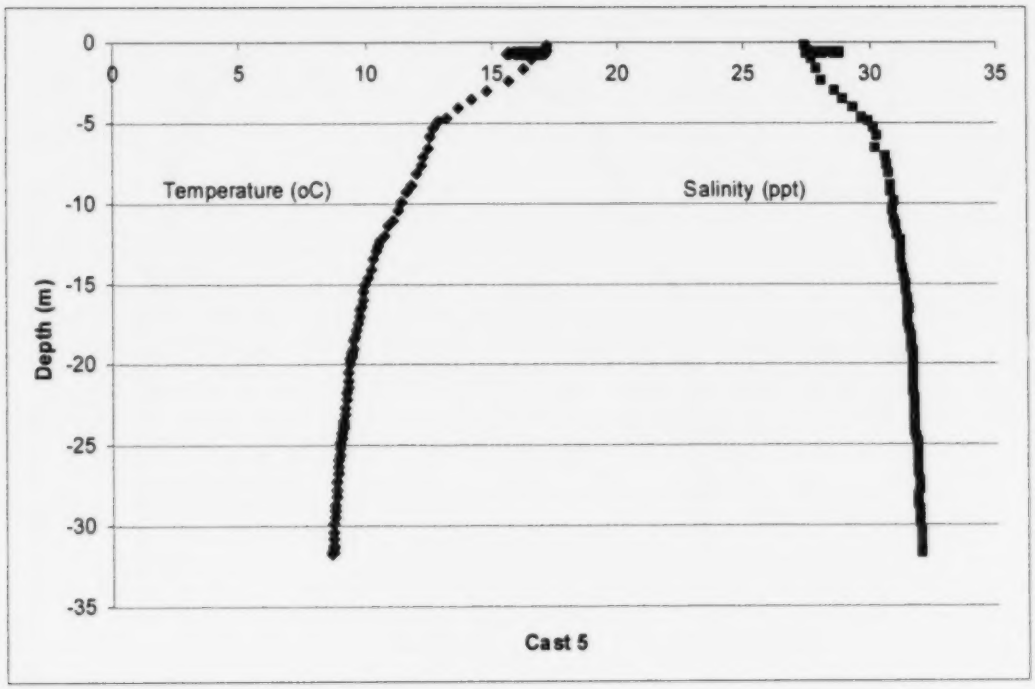


Figure 10 continued...



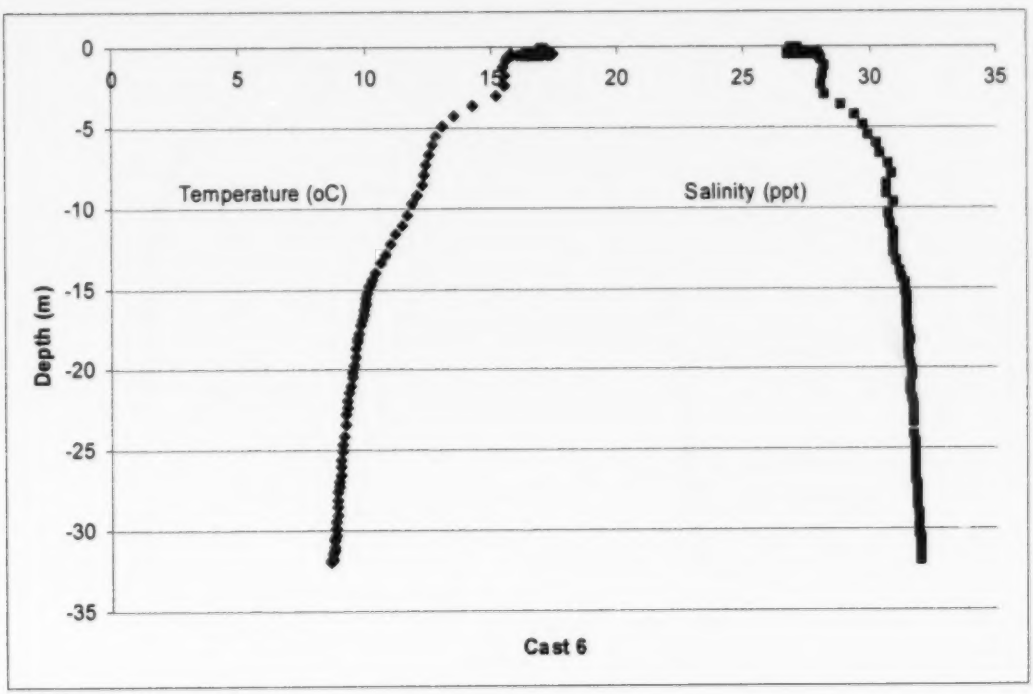
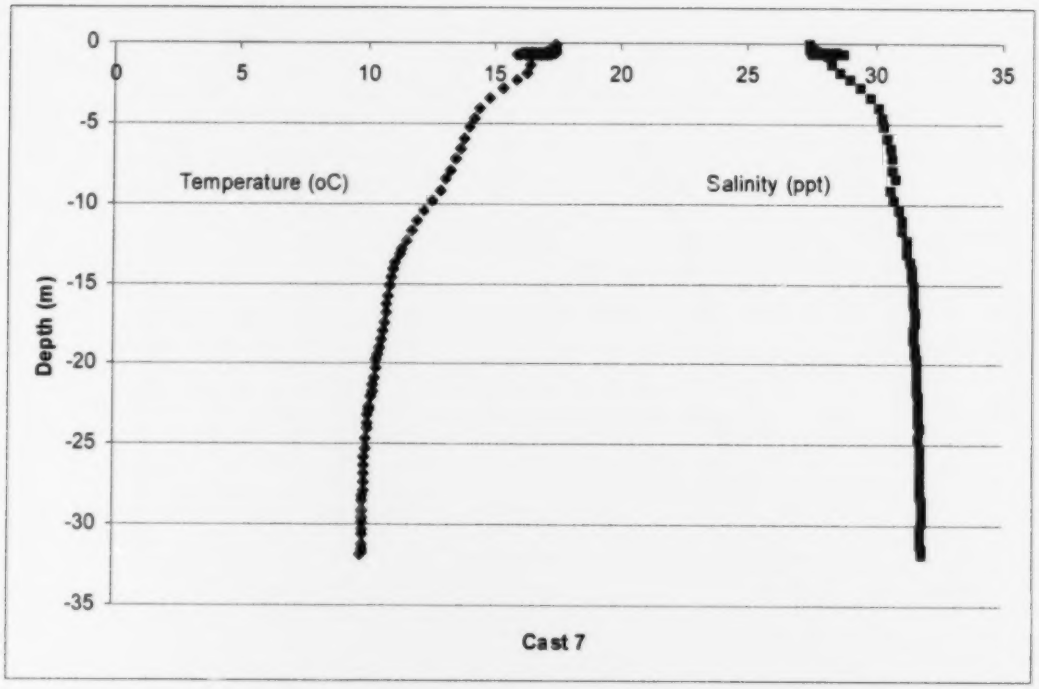


Figure 10 continued...



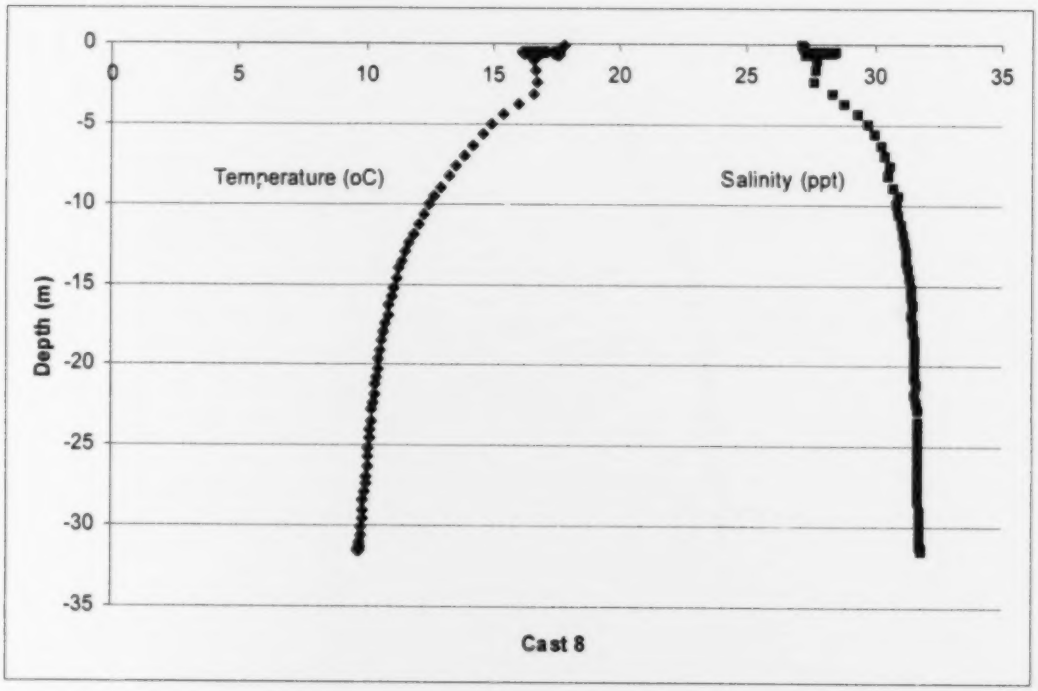
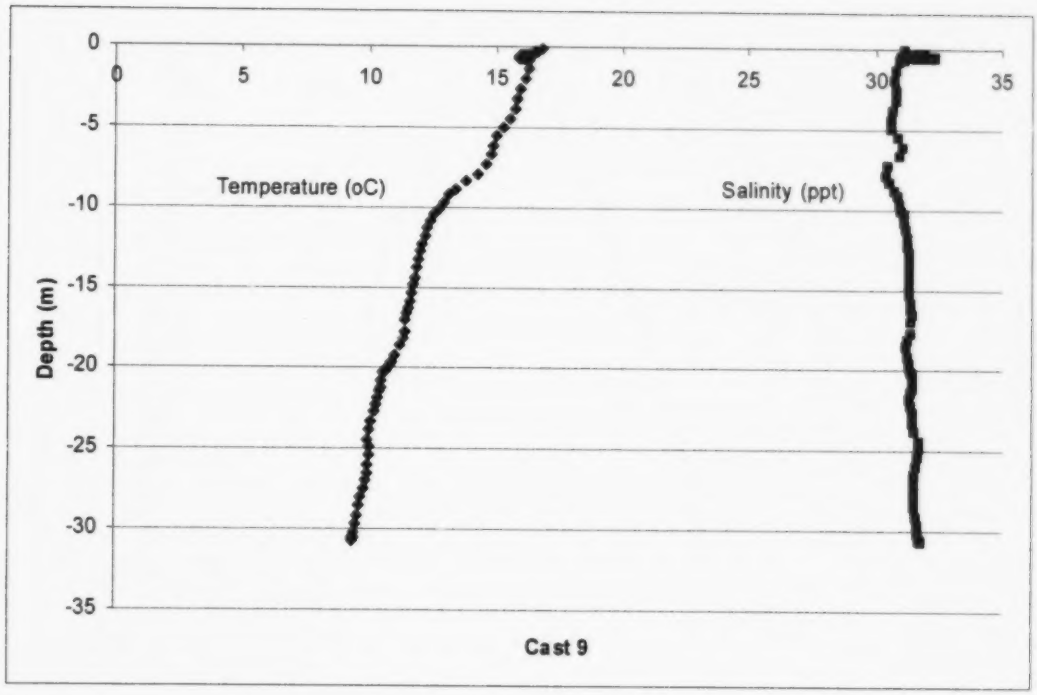


Figure 10 continued...



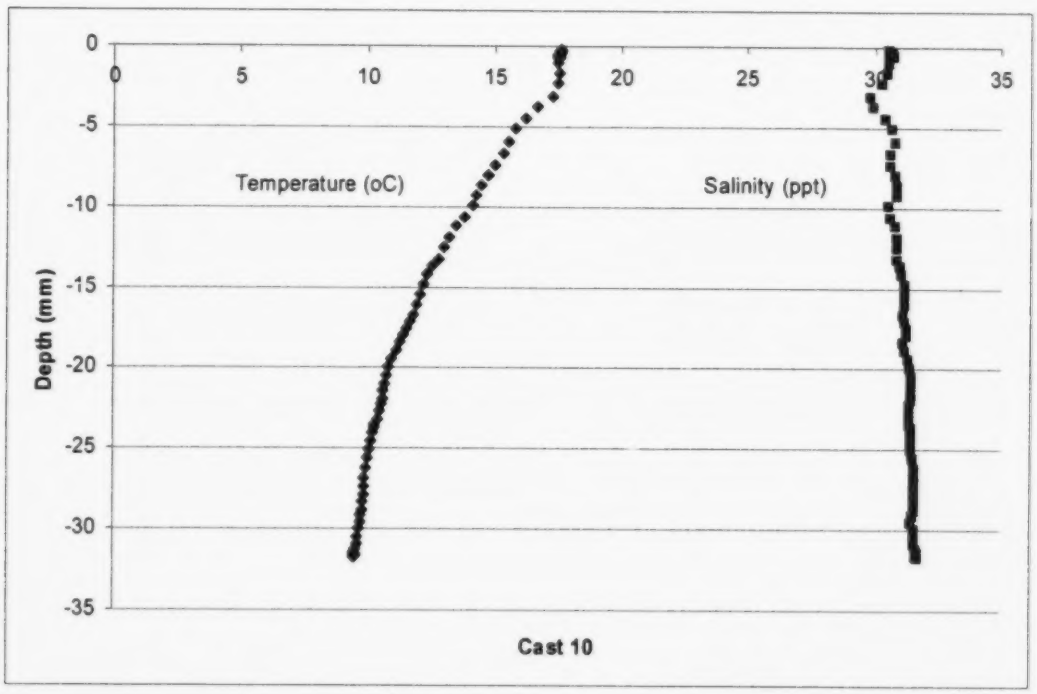
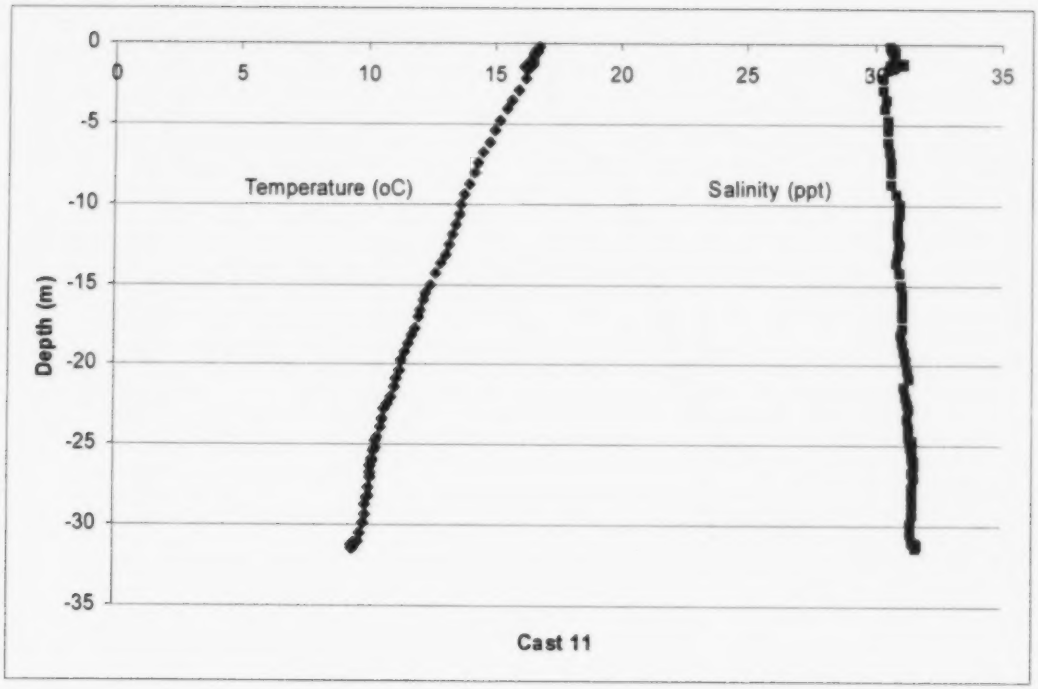


Figure 10 continued...



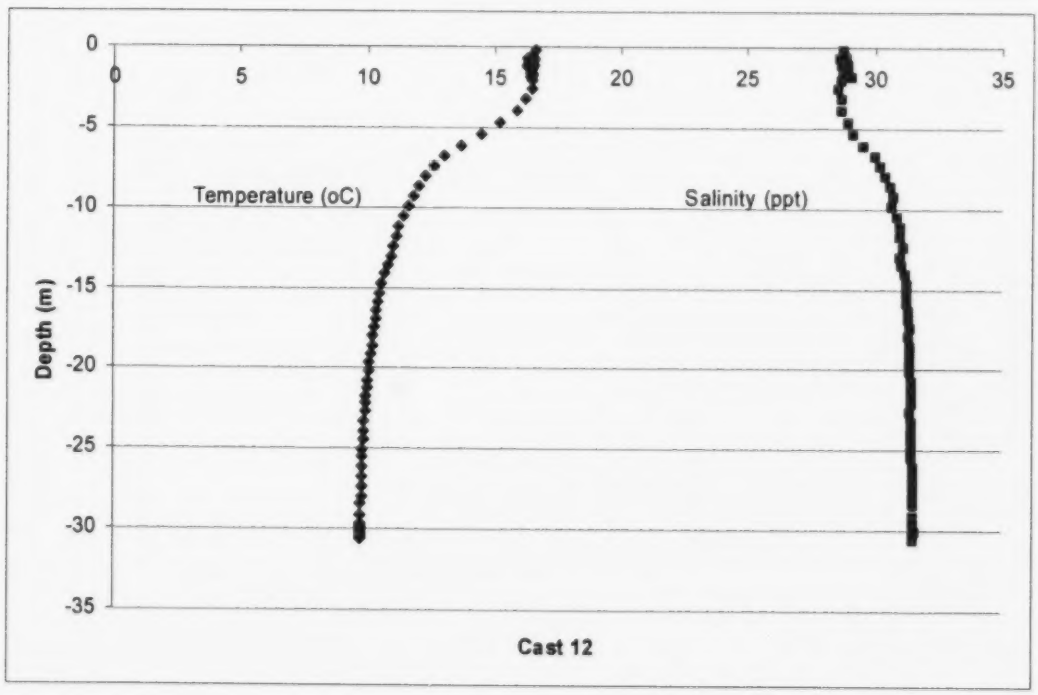
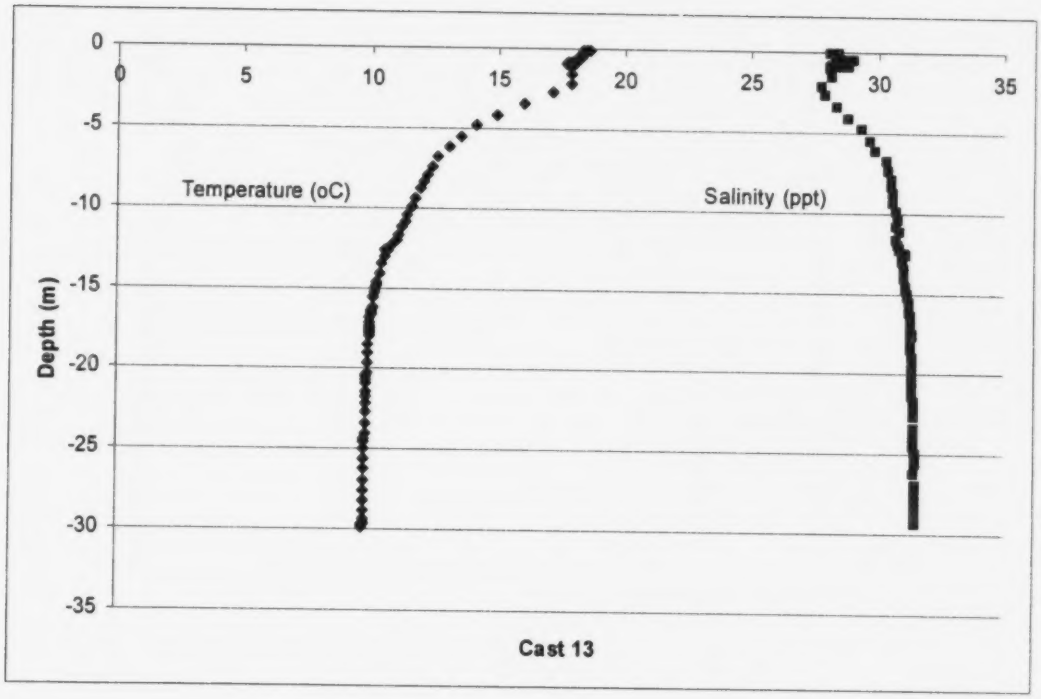


Figure 10 continued...



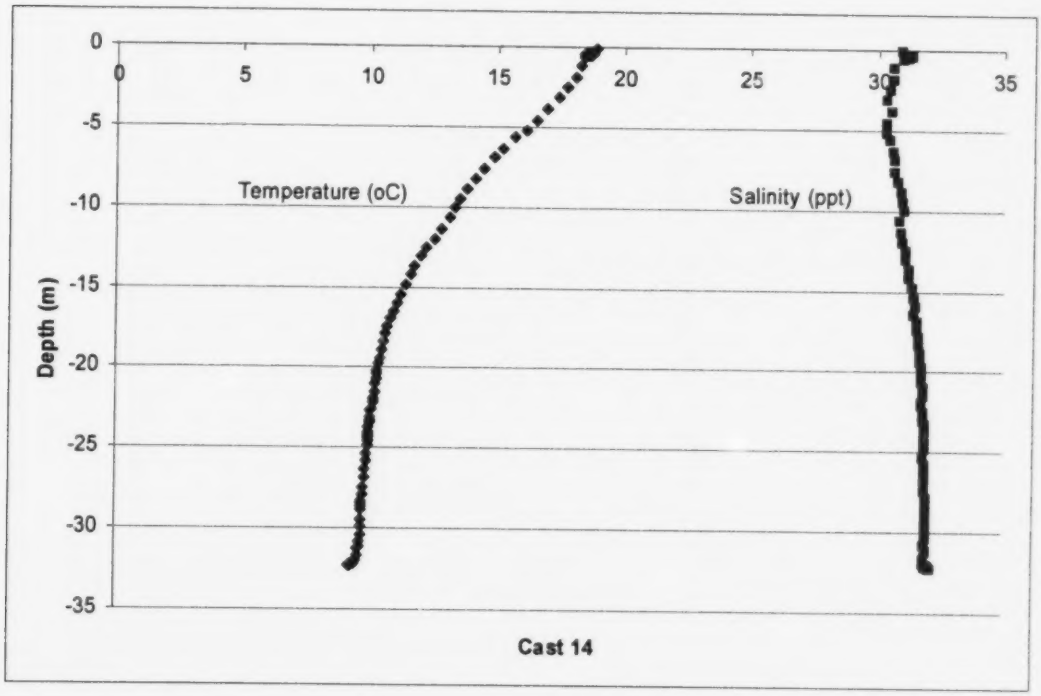
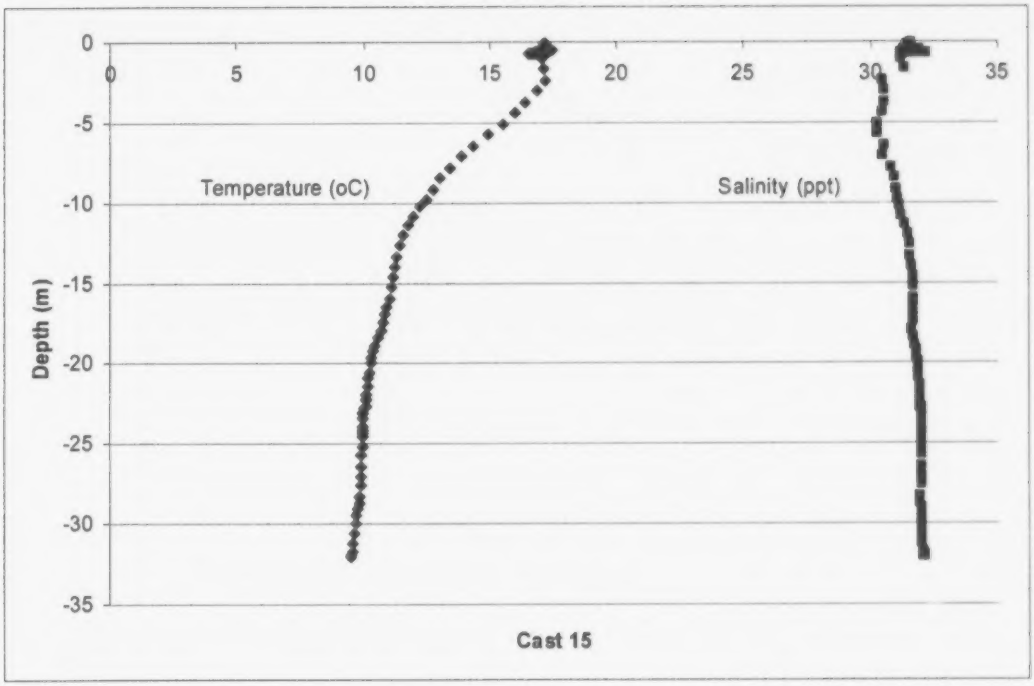


Figure 10 continued...



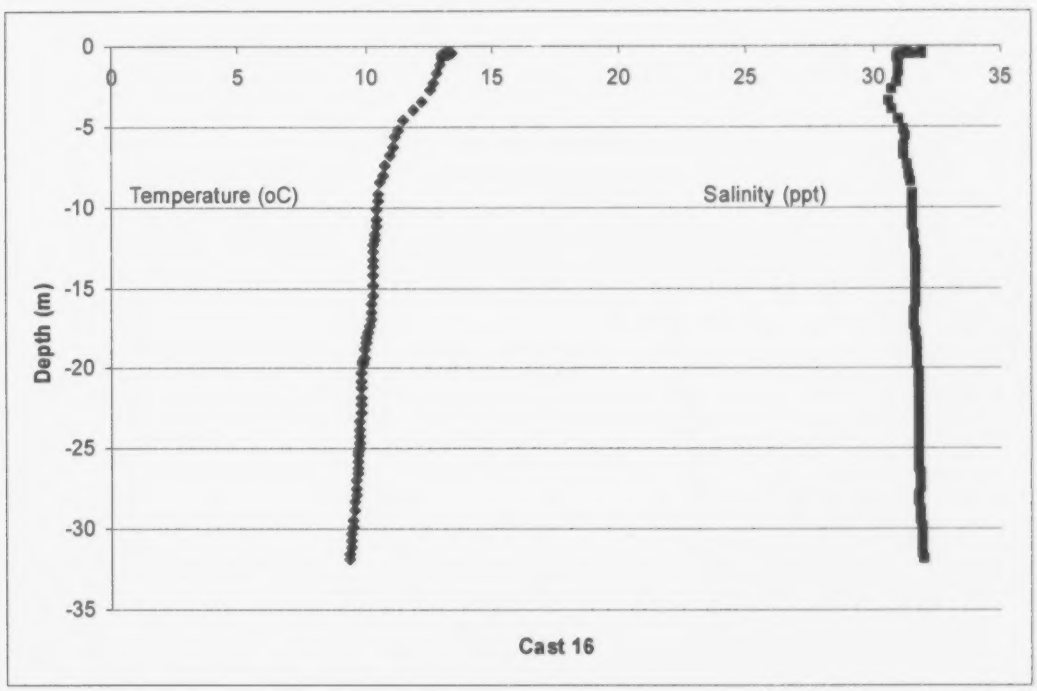
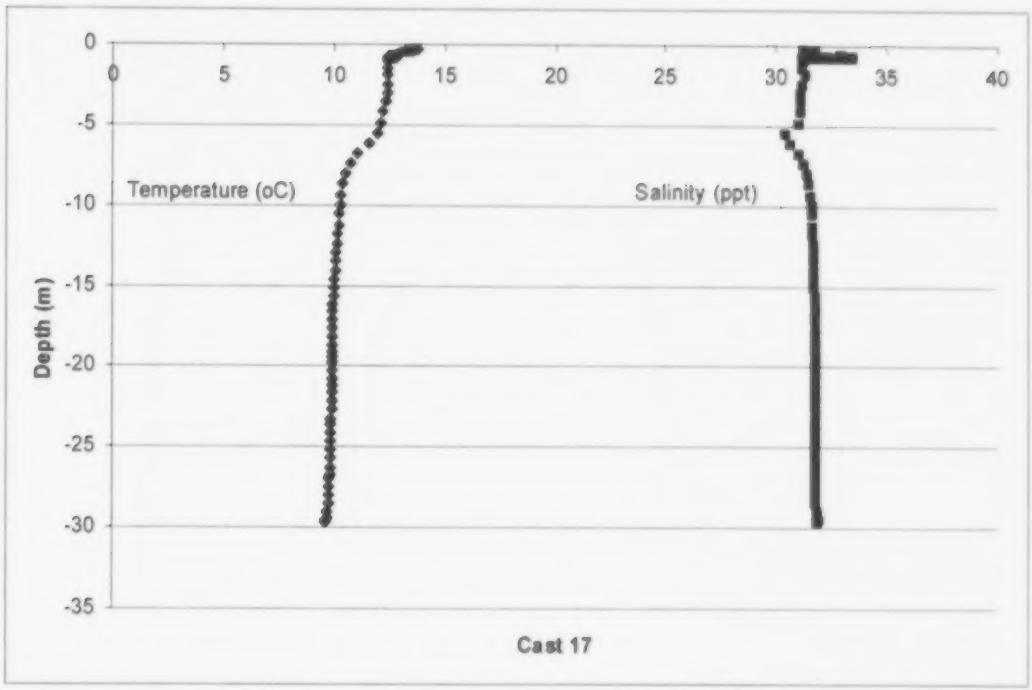


Figure 10 continued...



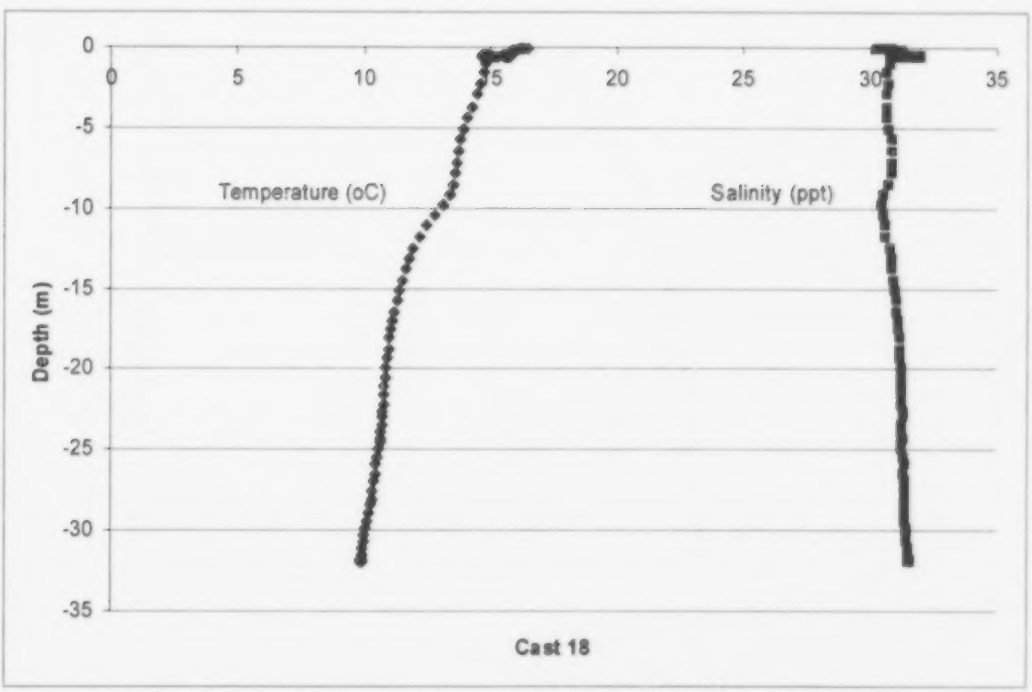
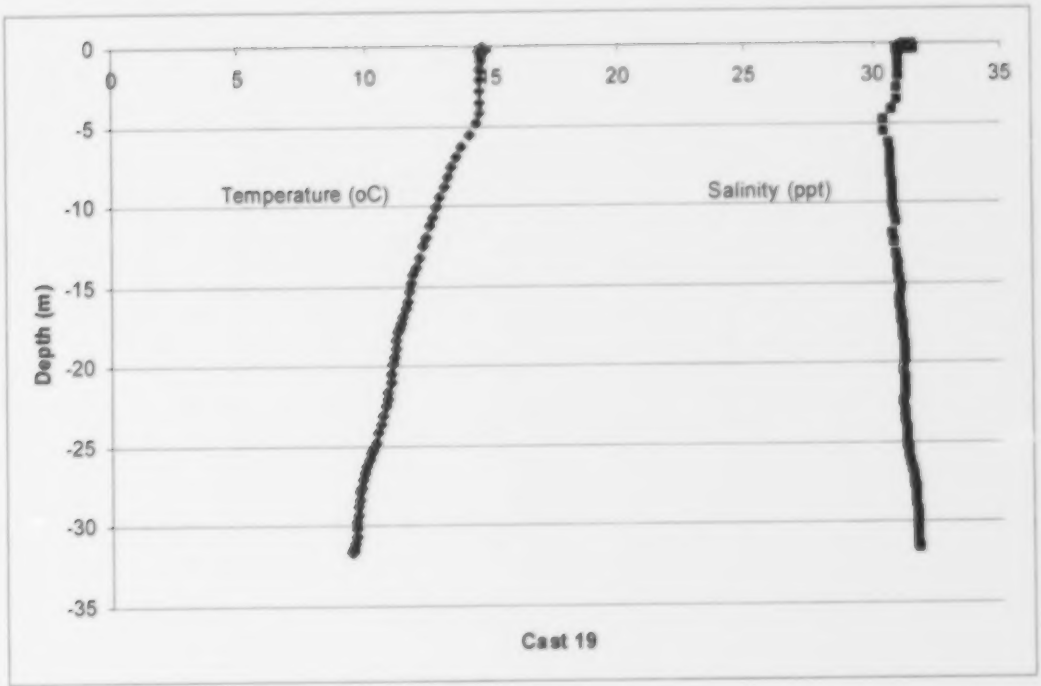


Figure 10 continued...



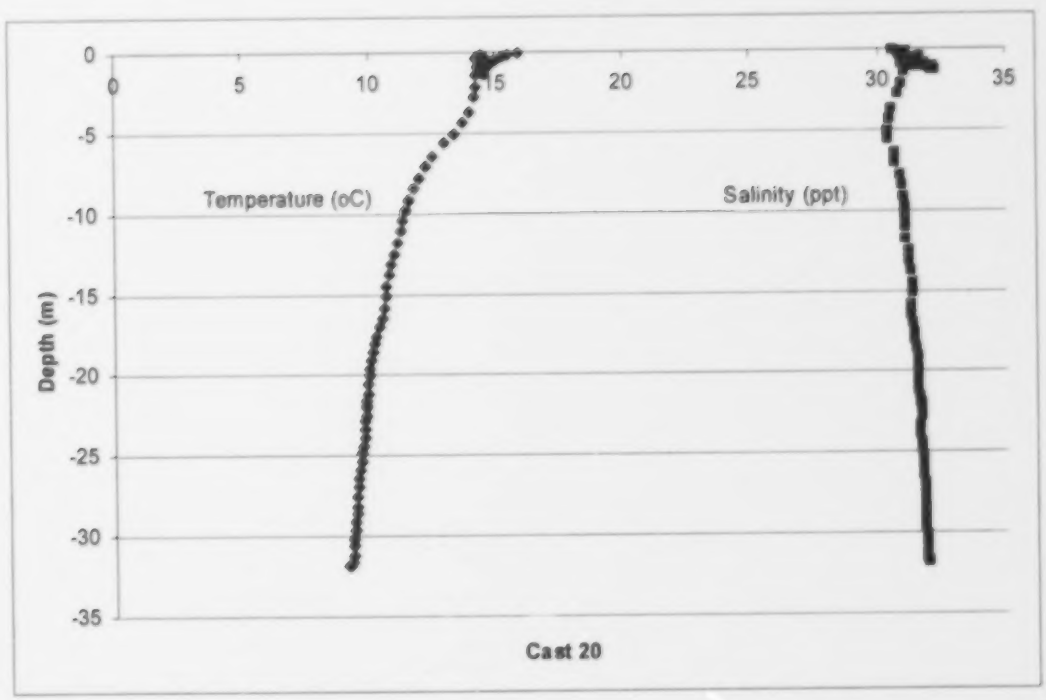
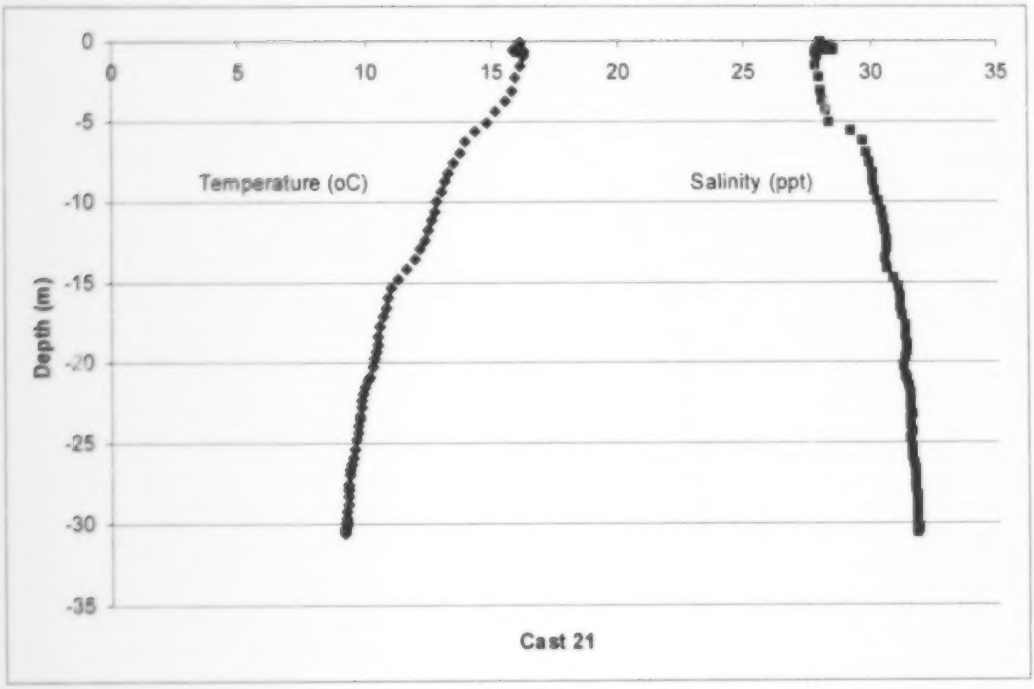


Figure 10 continued...



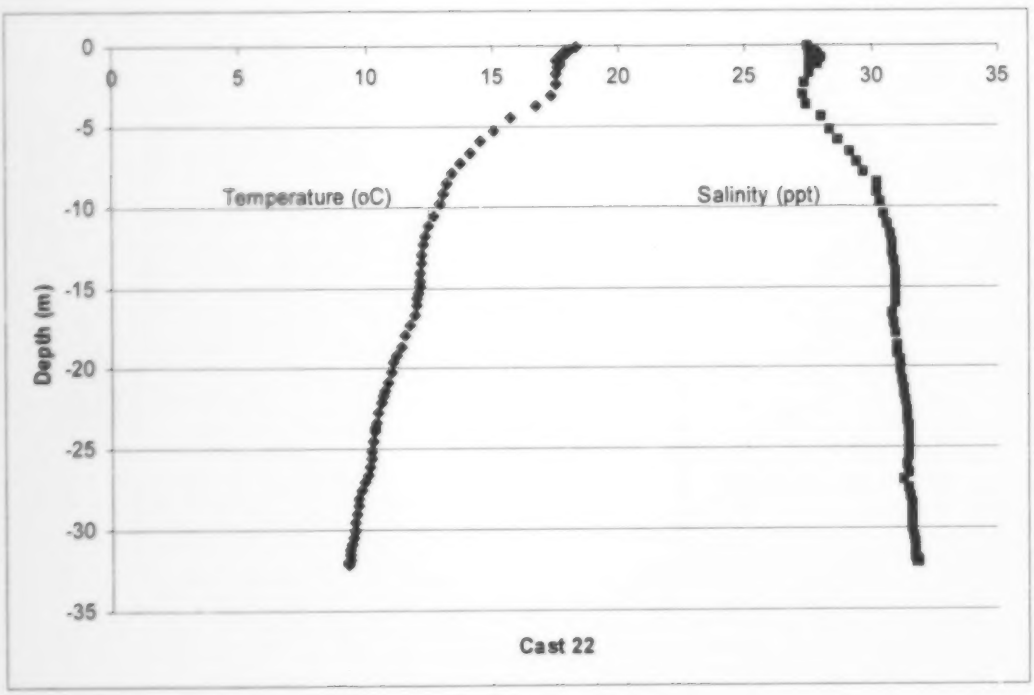
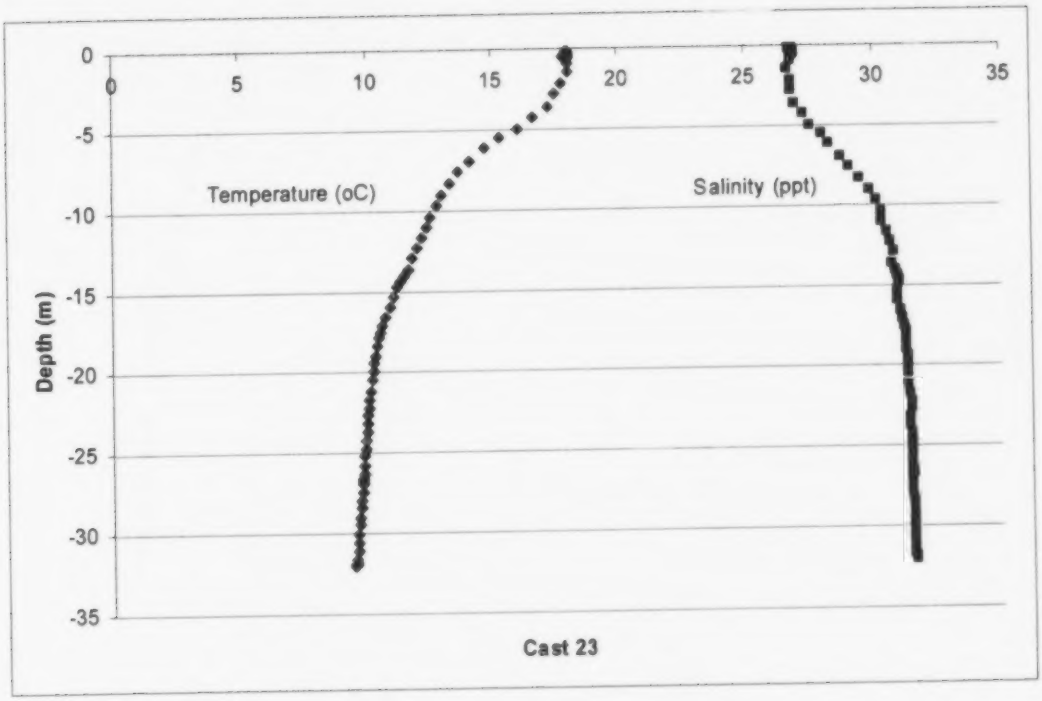


Figure 10 continued...



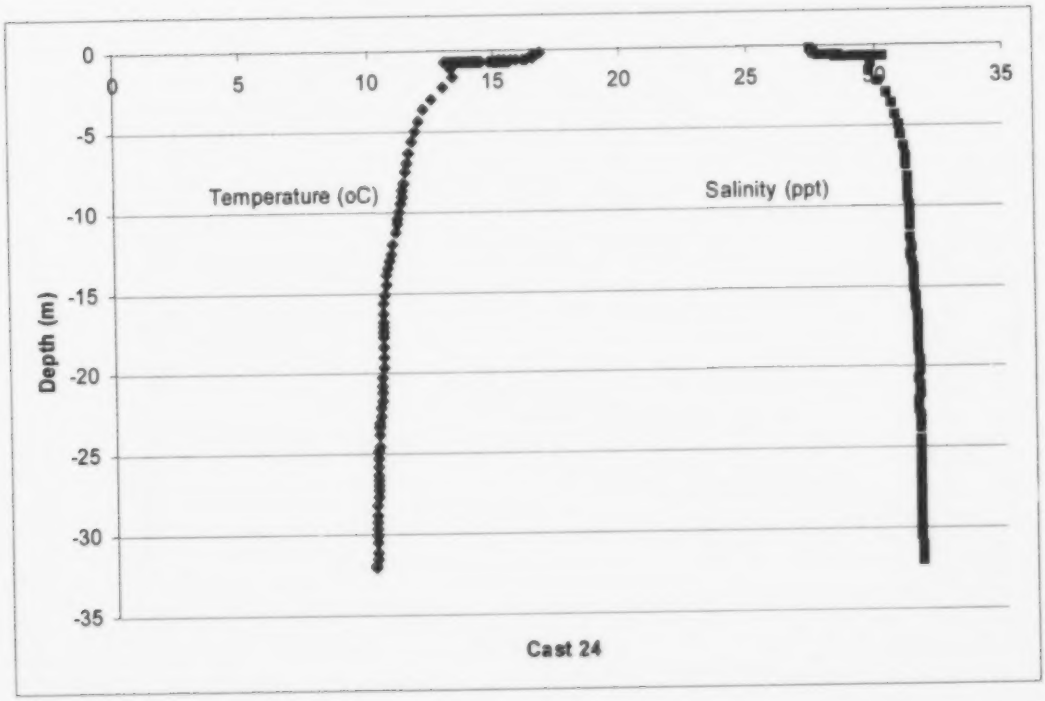
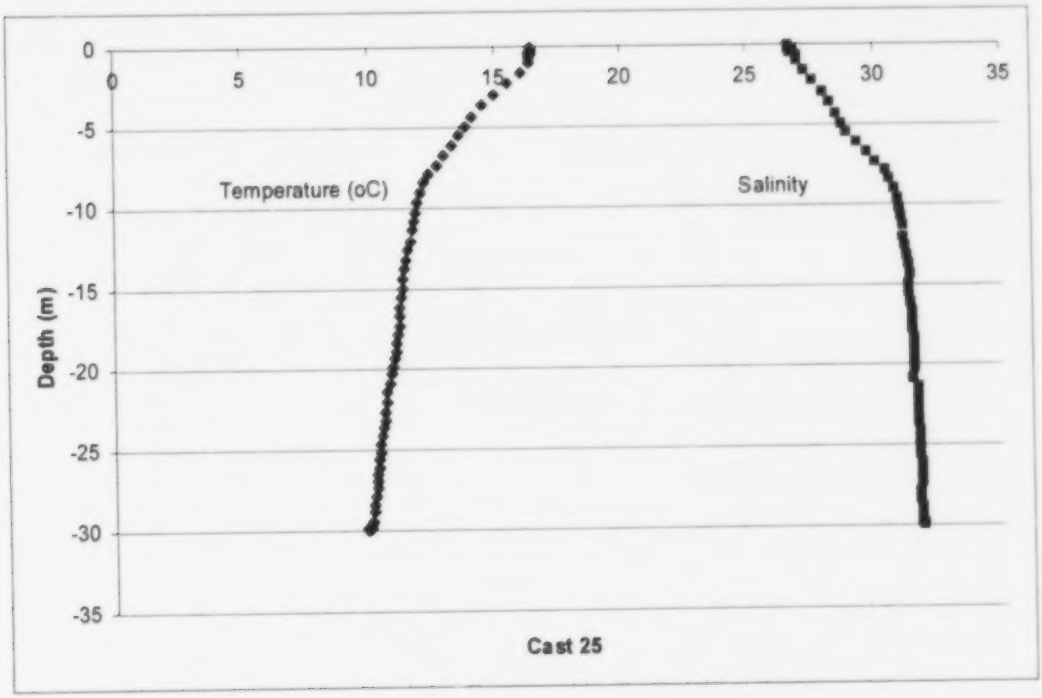


Figure 10 continued...



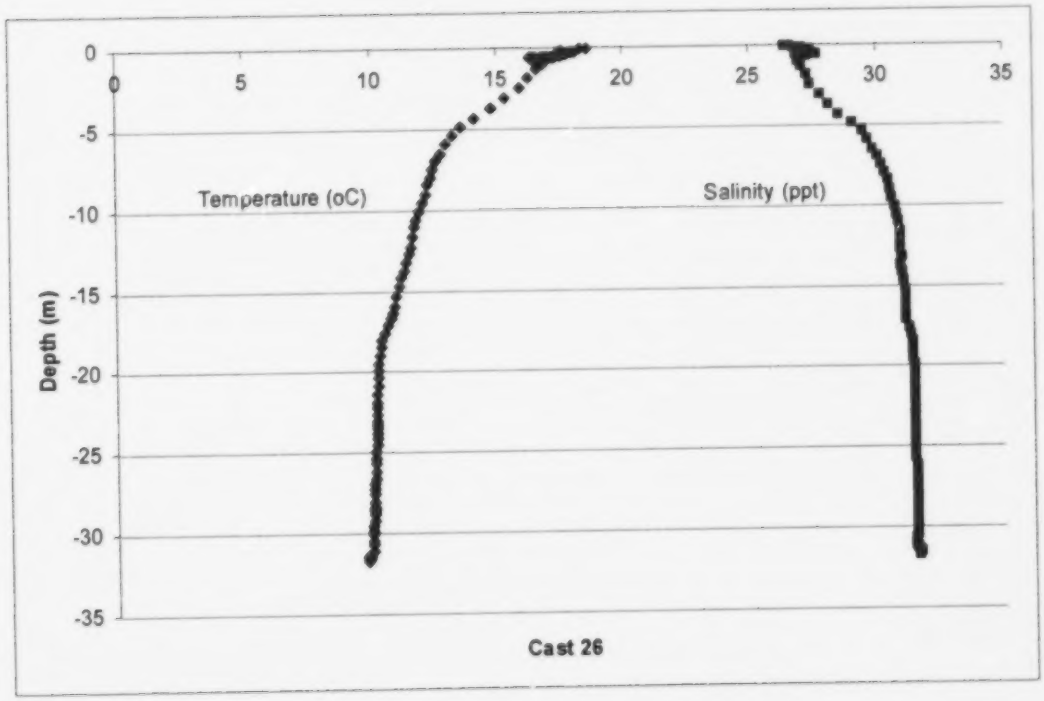


Figure 10 continued...

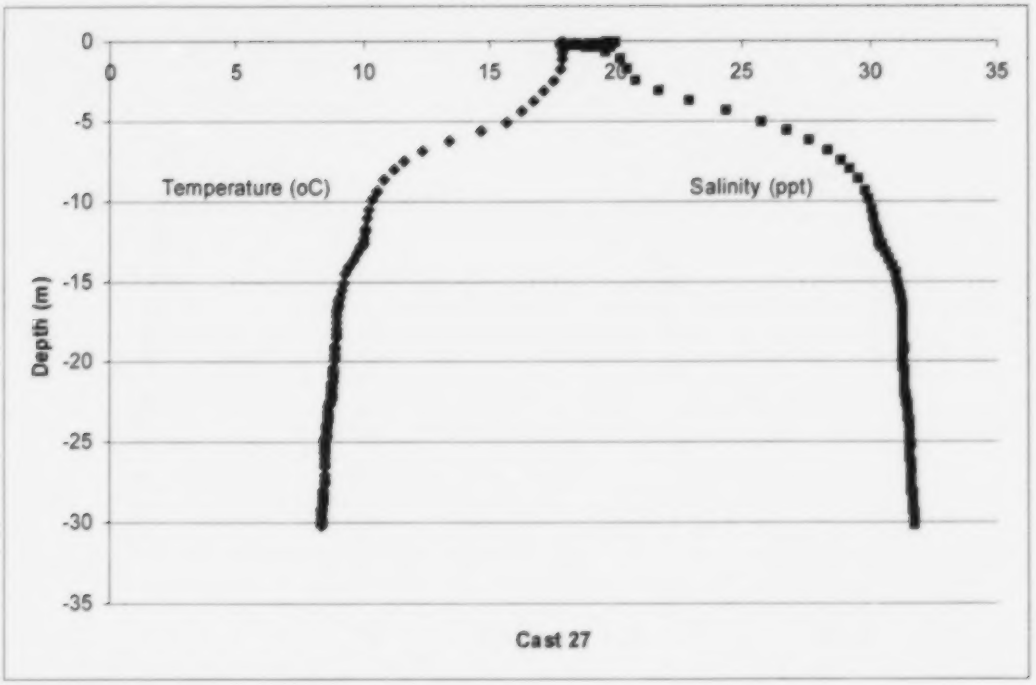


Figure 10 continued...

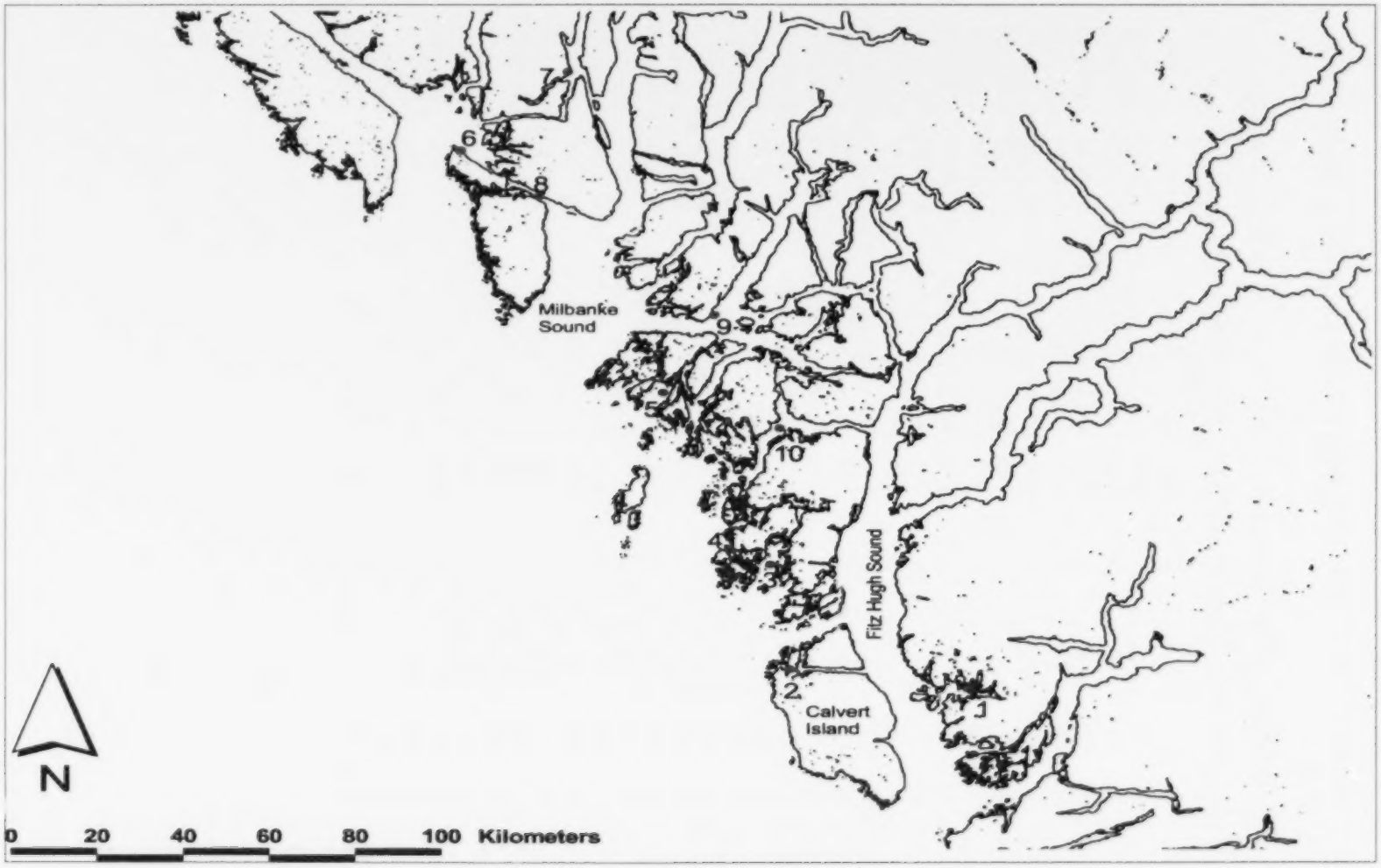


Figure 11. Central Coast gillnet sampling areas

Table 1. Details of the 32 sets made during the 2004 Central Coast juvenile herring survey.

Set	Month	Day	Set Code	Station	Section	Set Location Name	DD Lat (N)	DD Long (W)	Tow Time
1	8	9	1	4	091	Fish Egg Inlet	51.6470	127.8280	2200
2	8	9	1	2	091	Fish Egg Inlet	51.6040	127.7730	0020
3	8	9	1	1	091	Fish Egg Inlet	51.6210	127.7450	0130
4	8	10	2	3	085	Kwakshua Channel	51.6480	128.0910	2215
5	8	10	2	2	085	Kwakshua Channel	51.6550	128.0530	2255
6	8	10	2	4	085	Kwakshua Channel	51.6550	128.1150	2350
7	8	11	4	4	076	Kildidt Sound	51.8500	128.1160	2205
8	8	11	4	1	076	Kildidt Sound	51.8620	128.1460	2320
9	8	11	4	3	076	Kildidt Sound	51.8370	128.1540	0010
10	8	12	3	1	076	Spider Anchorage	51.8630	128.2380	2220
11	8	12	3	2	076	Spider Anchorage	51.8530	128.2352	2255
12	8	13	5	1	074	Thompson Bay	52.1210	128.4070	2240
13	8	13	5	2	074	Thompson Bay	52.1340	128.3780	2315
14	8	13	5	3	074	Thompson Bay	52.1480	128.3980	0040
15	8	15	9	1	072	Powell Anchorage	52.2910	128.3760	2210
16	8	15	9	2	072	Powell Anchorage	52.2840	128.3550	2240
17	8	16	7	1	067	Kitasu Bay	52.5500	128.7990	2210
18	8	16	7	2	067	Kitasu Bay	52.5450	128.7710	2335
19	8	16	7	3	067	Kitasu Bay	52.5410	128.7420	0025
20	8	17	6	2	067	Meyers Passage	52.6840	128.5770	2330
21	8	17	6	1	067	Meyers Passage	52.6730	128.5720	2250
22	8	18	8	2	077	East Higgins Pass	52.4360	128.5950	2205
23	8	18	8	3	077	East Higgins Pass	52.4710	128.6380	2300
24	8	18	8	4	077	East Higgins Pass	52.4920	128.6930	0005
25	8	19	10	2	072	Spiller Channel	52.2680	128.2710	2200
26	8	19	10	3	072	Spiller Channel	52.2770	128.2350	2245
27	8	19	10	4	072	Spiller Channel	52.2900	128.2590	2345
28	8	20	11	1	073	Hunter Channel	52.0570	128.1150	2155
29	8	20	11	3	073	Hunter Channel	52.0730	128.1350	2240
30	8	20	11	4	073	Hunter Channel	52.0780	128.1530	2315
31	8	21	12	2	084	Burke Channel	52.1239	127.4380	2115
32	8	21	12	3	084	Burke Channel	52.1693	127.4946	2205

Table 2. Species quantity and weights by set.

Set	Location Name	Species	Quantity	Weight (kg)
1	Fish Egg Inlet	**Herring**	53524	91.56
		Whitebait Smelt	12983	10.58
		Jellyfish		69.78
2	Fish Egg Inlet	**Herring**	9928	14.21
		Jellyfish		0.09
		Whitebait Smelt	803	0.79
3	Fish Egg Inlet	**Herring**	17791	58.70
		Juvenile Pollock	330	1.10
		Whitebait Smelt	518	0.49
		Three-spine Stickleback	47	0.016
		Spiny Dogfish	4	3.70
4	Kwakshua Channel	**Herring**	410	2.68
		Squid	51	0.76
		Pink salmon	1	1.00
		Jellyfish		0.76
5	Kwakshua Channel	**Herring**	76	0.83
		Sandlance	35	0.09
		Squid	30	0.74
		Spiny Dogfish	2	1.30
		Juvenile Rockfish	1	0.05
		Jellyfish		0.66
6	Kwakshua Channel	**Herring**	518	3.53
		Sandlance	14	0.03
		Pile Perch	3	0.007
		Pink salmon	1	1.60
		Prowfish	1	0.04
		Pacific Sardine	1	0.05
		Squid	1	0.03
		Jellyfish		0.09
7	Kildidt Sound	**Herring**	4	0.02
		Squid	82	1.80
		Prowfish	1	0.013
		Jellyfish		43.32
8	Kildidt Sound	**Herring**	263	5.70
		Squid	37	0.81
		Juvenile Pollock	19	0.22

Table 2 continued...

Set	Location Name	Species	Quantity	Weight (kg)
9	Kildidt Sound	**Herring**	226	5.26
		Juvenile Hake	10	0.12
		Coho salmon	5	1.30
		Squid	4	1.29
		Spiny Dogfish	1	0.10
		Jellyfish		0.070
10	Spider Anchorage	**Herring**	77	0.69
		Squid	46	0.86
		Juvenile Chinook salmon	1	0.11
11	Spider Anchorage	**Herring**	201	2.28
		Squid	32	0.44
		Juvenile Chinook salmon	1	0.12
		Juvenile Pollock	1	0.004
12	Thompson Bay	**Herring**	83	1.91
		Squid	21	0.46
		Jellyfish		0.70
13	Thompson Bay	**Herring**	172	3.10
		Pacific Sardine	218	47.23
		Squid	42	0.67
		Juvenile Hake	17	0.30
		Spiny Dogfish	7	
		Coho salmon	2	
14	Thompson Bay	**Herring**	58	1.10
		Squid	96	1.71
		Juvenile Pollock	2	0.004
		Spiny Dogfish	1	0.80
15	Powell Anchorage	**Herring**	45	0.17
		Juvenile Pollock	61	0.27
		Shiner Perch	5	0.02
		Squid	4	0.07
		Jellyfish		1.24
16	Powell Anchorage	**Herring**	490	1.89
		Squid	58	0.43
		Juvenile Pollock	10	0.05
		Snake Prickleback	6	0.007
		Pile Perch	3	0.008
		Three-spine Stickleback	1	0.002

Table 2 continued...

Set	Location Name	Species	Quantity	Weight (kg)
17	Kitasu Bay	**Herring**	813	5.26
		Squid	22	0.20
		Coho salmon	5	15.00
		Juvenile Pollock	1	0.005
		Pink salmon		18.90
		Sockeye salmon		1.80
18	Kitasu Bay	**Herring**	183	1.17
		Pacific Sardine	39	9.10
		Juvenile Pink salmon	2	0.08
19	Kitasu Bay	**Herring**	5536	24.05
		Squid	28	0.46
20	Meyers Passage	**Herring**	4072	29.50
		Three-spine Stickleback	13	0.03
		Squid	6	1.68
		Jellyfish		1.49
21	Meyers Passage	**Herring**	191	1.11
		Squid	2	0.03
		Three-spine Stickleback	2	0.004
		Jellyfish		0.04
22	East Higgins Pass	**Herring**	1	0.004
23	East Higgins Pass	**Herring**	80	0.26
		Pacific Sardine	45	10.71
		Hake	1	1.60
24	East Higgins Pass	**Herring**	161	0.76
		Squid	56	0.98
		Juvenile Pollock	2	0.003
		Spiny Dogfish	1	0.60
		Sculpin	1	0.001
		Jellyfish		0.07
25	Spiller Channel	**Herring**	9724	42.40
26	Spiller Channel	**Herring**	8073	41.46
		Chinook salmon	12	9.80
		Juvenile Hake	12	0.006
27	Spiller Channel	**Herring**	943	3.90
		Juvenile Pollock	3	0.008
		Jellyfish		0.01

Table 2 continued...

Set	Location Name	Species	Quantity	Weight (kg)
28	Hunter Channel	**Herring**	8751	42.95
		Whitebait Smelt	24455	27.84
29	Hunter Channel	**Herring**	1053	13.49
30	Hunter Channel	**Herring**	6494	35.38
31	Burke Channel	**Herring**	6993	43.93
		Whitebait Smelt	66	0.05
		Three-spine Stickleback	9	0.001
		Spiny Dogfish	1	1.20
32	Burke Channel	**Herring**	6204	43.12
		Whitebait Smelt	602	0.54
		Spiny Dogfish	3	2.20

Table 3. Percent species occurrence in all 2004 Central Coast sets.

Common Name	Scientific Name	Set Numbers	Percent Occurrence
0+ Herring	*Clupea pallasi* in year of birth	1,2,3,4,5,6,7,8,9,10,11,12,14,15,16,17,18,19,20,21, 22,23,24,25,26,27,28,29,30,31,32	96.9
1+ Herring	*Clupea pallasi* in year after birth	3,4,5,6,8,9,10,11,12,13,14,15,16,17,18,20,21,24, 28,29,30,31,32	71.9
2+ Herring	*Clupea pallasi* in 2nd year after birth	4,6,9,12,17	15.6
No Herring caught	*Clupea pallasi*		0
Squid	*Loligo opalescens*	4,5,6,7,8,9,10,11,12,13,14,15,16,17,19,20,21,24	56.3
Jellyfish	*Cnidaria*	1,2,4,5,6,7,9,12,15,20,21,24,27	40.6
Walleye pollock	*Theragra chalcogramma*	3,8,11,14,15,16,17,24,27	28.1
Spiny dogfish	*Squalus acanthias*	3,5,9,13,14,24,31,32	25.0
Whitebait smelt	*Allosmerus elongatus*	1,2,3,28,31,32	18.8
Three-spine stickleback	*Gasterosteus aculeatus*	3,16,20,21,31	15.6
Pacific hake	*Merluccius productus*	9,13,23,26	12.5
Pacific sardine	*Sardinops sagax*	6,13,18,23	12.5
Pink salmon	*Oncorhyncus gorbuscha*	4,6,17,18	12.5
Chinook salmon	*Oncorhyncus tshawytscha*	10,11,26	9.4
Coho salmon	*Oncorhyncus kisutch*	9,13,17	9.4
Pile Perch	*Rhacochilus vacca*	6,16	6.3
Prowfish	*Zaprora silenus*	6,7	6.3
Sandlance	*Ammodytes hexapterus*	5,6	6.3
Rockfish	*Sebastes sp.*	5	3.1
Sculpin	*Leptocottus armatus*	24	3.1
Shiner perch	*Cymatogaster aggregata*	15	3.1
Snake prickleback	*Lumpenus sagitta*	16	3.1
Sockeye salmon	*Oncorhyncus nerka*	17	3.1

Table 4. Mean lengths and weights for age-0+ and age-1+ herring and total catch weight by set location.

Set Location	Mean 0+ Length (mm)	Mean 0+ Weight (g)	Mean 1+ Length (mm)	Mean 1+ Weight (g)	Total Catch Weight (kg)
Fish Egg Inlet	53.5	1.69	103.0	12.82	164.47
Kwakshua Channel	76.2	5.33	119.6	22.36	7.04
Kildidt Sound	75.1	5.04	122.3	23.49	10.97
Spider Anchorage	74.6	5.08	111.9	18.70	2.97
Thompson Bay	73.0	5.14	116.4	20.29	6.10
Meyers Passage	77.1	4.63	116.2	20.24	30.61
Kitasu Bay	76.0	5.37	114.7	18.86	30.49
East Higgins Passage	69.0	3.67	112.4	17.64	1.02
Powell Anchorage	63.3	3.22	105.1	14.99	2.06
Spiller Channel	73.3	4.38	-	-	87.72
Hunter Channel	75.7	5.02	112.2	16.88	91.83
Burke Channel	81.3	6.35	115.7	19.35	87.05
All Locations	72.3	4.58	113.6	18.69	522.33

Table 5. Categories of organisms, by phylum, identified in plankton and stomach samples. The four letter abbreviations are used to identify organisms in Tables 7, 9 and 10.

Coelenterata	
COEL	Medusae
SIPH	Siphonophores
Ctenophora	
CTEN	Ctenophores
Annelida	
POLY	Polychaetes – segmented worms
Mollusca	
GAST	Prosobranch gastropods
PELE	Pelecypods
PTER	Pteropods - mostly *Clione sp.* and *Limacine sp.*
SQUI	Squid
Arthropoda	
AMPH	Amphipods
BARN	Barnacle, unknown stage
BARNc	Barncacle cyprids
BARNn	Barnacle nauplius
CLAD	Cladocerans; *Podon sp.* and *Evadne sp.*
CNAU	Unidentified copepod nauplii
COPE	Copepods (See Table 6 for a list of species)
CRAM	Crab megalopea, including porcillinadea
CRAZ	Crab zoea, including porcillinadea
EUPA	Euphausiid adults
EUPH	Euphausiid, unknown stage
EUPL	Euphausiid larvae (nauplii, protozoea and zoea)
NAUP	Crustacean nauplii
OSTR	Ostracods
SHRI	Shrimp (natant decapod) zoea
Ectoprocta	
ECTO	Ectoprocts, mostly *Membranipora sp.* larvae (cyphonautes)
Echinodermata	
ECHI	Echinoderm larvae
Chaetognatha	
CHAE	Chaetognaths, mostly *Sagitta sp.*
Chordata	
LARV	Larvaceans, mostly *Oikopleura sp.*, and tunicate larvae
TELA	Teleost larvae
Miscellaneous	
EGGS	Unidentified eggs, euphausiid or teleost
DIAT	Diatoms

Table 6. Calanoid, cyclopoid and harpacticoid copepods identified in plankton and stomach samples. The four letter abbreviations are used to identify organisms in Tables 7, 9 and 10.

Calanoid copepods	
ACLA	*Acartia clausi.*
ALON	*Acartia longiremis*
CABD	*Centropages abdominales*
CALA	*Calanus sp.*
CCOL	*Cadacia columbiae*
CGRA	*Chiridius gracilis*
CMAR	*Calanus marshallae*
CPAC	*Calanus pacificus*
EBUN	*Eucalanus bungii*
EELO	*Eucalanus elongatus*
ELON	*Epilabidocera longipedata*
JCAL	Juvenile calanoids, unknown species
MPAC	*Metridia pacifica*
MPSE	*Metridia pseudopacifica*
OBOR	*Oncaea borealis*
PMIN	*Pseudocalanus minitus*
PPAR	*Paracalanus parvus*
PSEU	*Pseudocalanus sp.*
TDIS	*Tortanus discaudatus*
UCAL	Unidentified calanoids, unknown species
Cyclopoid copepods	
CANG	*Corcaeeus anglicus*
OITH	*Oithona* sp.
UCYC	Unidentified cyclopoid, unknown species
Harpacticoid copepods	
UHAR	Unidentified harpacticoid, unknown species

Table 7. Zooplankton density per set in number of organisms per m^3 of water sampled. Species codes located in Tables 5 and 6.

Set	Location	Water Volume (m^3)	ACLA	ALON	AMPH	BARN	BARNn	CABD	CANG	CCOL	CHAE	CLAD	CMAR	CNAU
1	Fish Egg Inlet	17.5317	47.5	292.0	3.7	-	40.5	21.9	-	-	-	18.3	-	-
3	Fish Egg Inlet	18.7499	-	41.0	42.7	27.3	-	-	-	-	-	-	6.8	-
4	Kwakshua Channel	11.7112	-	235.0	181.7	-	258.2	65.6	-	-	10.9	87.4	9.6	-
6	Kwakshua Channel	8.7887	-	269.4	7.5	320.6	-	72.8	7.3	-	-	87.4	-	-
7	Kildidt Sound	10.4092	-	147.6	-	-	198.3	147.6	-	-	-	2262.6	-	-
8	Kildidt Sound	15.1006	-	67.8	36.0	-	35.0	169.5	-	-	3.2	423.8	-	-
10	Spider Anchorage	12.9766	-	231.8	0.5	93.7	-	49.3	-	-	-	266.3	-	-
12	Thompson Bay	18.9282	-	649.2	9.3	-	216.4	2059.2	27.0	-	-	595.1	1.7	-
14	Thompson Bay	18.0619	-	226.8	1.1	-	127.6	767.6	-	-	14.6	1644.1	0.2	-
15	Powell Anchorage	16.4293	-	17.5	-	-	64.8	3.9	-	-	-	-	0.2	-
17	Kitasu Bay	8.1129	-	4196.8	-	-	-	599.5	-	-	-	-	-	-
19	Kitasu Bay	10.6956	-	3255.2	-	-	-	612.6	-	-	-	47.9	-	-
21	Meyers Anchorage	12.8577	-	119.5	2.2	-	329.5	70.0	-	-	0.6	29.9	-	-
22	East Higgins Pass	16.9763	-	346.8	4.5	0.2	-	18.8	-	-	2.1	-	-	-
24	East Higgins Pass	12.1287	-	253.3	14.5	-	95.6	26.4	-	-	-	200.5	-	-
25	Spiller Channel	19.3769	-	143.7	0.2	-	44.7	14.9	-	-	-	-	0.1	-
26	Spiller Channel	17.8433	-	430.4	8.4	-	53.8	17.9	-	-	0.2	50.2	1.9	-
28	Hunter Channel	18.4292	-	53.8	2.6	-	62.0	14.8	-	-	-	23.4	-	-
29	Hunter Channel	18.7644	-	289.9	67.6	-	116.0	98.9	-	0.9	0.6	6.8	0.4	-
31	Burke Channel	12.8494	-	17.4	-	-	58.5	-	5.0	-	-	62.3	-	42.3
32	Burke Channel	10.3193	-	43.4	7.0	-	152.5	-	-	1.0	-	58.9	-	-

Table 7 continued...

Set	COEL	COPE	CPAC	CRAM	CRAZ	CTEN	EBUN	ECHI	ECTO	EELO	EGGS	ELON	EUPA	EUPH	EUPL	GAST	JCAL
1	4.1	-	-	4.2	33.5	1.1	-	-	-	-	-	-	-	-	3.7	7.3	21.9
3	-	-	-	0.9	2.6	-	-	-	-	-	-	-	47.8	-	-	-	389.1
4	16.4	-	1.4	1.4	20.5	4.1	-	-	32.8	-	103.8	-	-	-	207.7	-	169.4
6	1.1	-	-	0.5	29.8	63.0	-	-	65.5	-	123.8	-	-	-	356.8	-	65.5
7	0.8	-	-	3.1	562.6	3.8	-	-	49.2	-	-	-	-	-	-	24.6	295.1
8	-	-	1.1	3.7	94.8	1.6	-	-	33.9	-	796.8	-	8.5	-	160.5	17.0	836.0
10	0.9	4.9	9.9	0.2	60.6	5.4	-	-	24.7	-	-	-	-	-	187.6	-	88.8
12	0.8	-	4.2	1.7	230.8	0.8	-	-	-	-	-	-	-	442.1	-	-	168.2
14	1.1	-	3.8	0.4	69.3	1.6	-	-	14.2	-	14.2	-	-	-	71.3	-	99.7
15	15.8	-	0.2	1.0	20.9	3.9	-	-	3.9	-	-	-	-	-	1.9	11.7	33.8
17	1.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	31.6	473.3
19	1.5	-	-	5.6	45.3	0.7	-	-	-	-	23.9	0.4	-	-	0.7	-	407.6
21	41.1	-	-	0.9	1.6	28.6	-	-	10.0	-	109.5	-	-	-	481.3	-	52.0
22	-	-	-	2.6	3.5	-	-	-	7.5	-	37.7	-	5.2	-	25.2	-	139.5
24	25.7	-	-	6.6	66.6	0.7	-	-	47.5	-	36.9	-	-	-	46.2	5.3	21.1
25	0.4	-	0.1	0.6	3.5	2.2	0.1	-	23.1	-	41.3	-	-	-	20.4	1.7	44.6
26	7.6	-	0.7	0.8	0.1	0.4	-	-	7.2	-	61.0	-	2.6	-	9.5	14.3	140.3
28	14.1	-	-	-	14.8	6.6	-	-	4.3	-	6.9	0.1	-	-	9.7	0.9	18.4
29	7.5	-	-	0.6	14.3	35.6	-	-	-	-	37.5	-	0.6	-	52.7	-	234.7
31	20.5	-	-	-	3.7	66.0	1.9	5.0	7.5	-	226.6	-	-	-	28.0	-	74.7
32	5.0	-	-	-	-	29.5	1.6	12.4	-	0.6	96.1	-	1.2	-	18.8	-	73.5

Table 7 continued...

Set	LARV	MPSE	NAUP	OITH	OSTR	PELE	PMIN	POLY	PPAR	PSEU	PTER	SHRI	SIPH	SQUI	TDIS	TELA	UCAL
1	18.3	-	2.1	-	-	-	-	3.7	-	-	-	5.5	0.5	-	-	-	-
3	6.8	356.7	-	-	-	-	6.8	-	-	-	0.9	-	-	-	-	-	-
4	245.9	133.9	-	-	-	-	169.4	-	-	-	5.5	2.7	16.4	-	-	-	12.3
6	240.3	1.4	-	7.3	-	0.5	-	7.3	29.1	-	-	0.2	-	-	-	0.5	0.5
7	418.1	-	0.8	-	-	-	24.6	24.6	24.6	-	-	132.2	0.8	-	-	-	-
8	101.7	93.2	-	-	-	-	-	-	-	745.9	-	23.8	-	0.5	-	-	-
10	108.5	-	-	-	-	-	54.3	14.8	-	-	-	2.3	5.7	-	-	-	-
12	81.1	1.7	-	-	-	-	216.4	-	-	-	-	35.5	-	-	-	-	-
14	14.2	0.2	0.2	-	-	-	14.2	-	-	-	-	52.5	28.6	-	-	-	-
15	171.4	-	-	-	-	-	-	5.8	1.9	-	-	27.5	145.6	-	1.9	-	-
17	47.3	-	-	-	-	-	2161.5	-	31.6	-	-	15.8	-	-	-	-	-
19	95.7	-	-	23.9	-	-	789.9	-	47.9	-	-	9.7	1.1	-	-	-	-
21	149.3	0.6	-	10.0	-	-	69.7	10.0	-	-	-	-	32.0	-	-	-	-
22		96.4	-	-	-	-	452.4	-	30.2	-	-	1.6	-	-	-	-	-
24	63.3	0.7	-	10.6	-	-	5.3	15.8	5.3	-	-	33.6	490.1	-	-	-	-
25	11.6	-	-	1.7	-	-	-	9.9	1.7	-	-	1.0	7.7	-	-	0.1	-
26	7.2	59.5	-	-	-	-	68.1	8.2	10.8	-	-	9.9	9.3	-	-	-	-
28	17.4	0.1	-	0.9	-	7.8	-	4.3	1.7	-	-	7.7	1.0	-	0.9	-	-
29	30.7	0.4	-	-	-	6.8	-	30.7	-	92.1	-	9.4	-	-	-	0.2	-
31	27.4	-	-	7.5	-	29.9	42.3	113.3	5.0	-	12.5	1.2	11.8	-	-	-	-
32	207.8	-	-	-	3.1	-	-	20.9	3.1	65.1	-	3.1	1.6	-	-	-	-

Table 8. Herring stomach fullness (%) and state of digestion (%). Blank refers to no data provided.

Age-0+	State of Digestion											
Fullness	0	10	20	25	30	40	50	60	80	90	blank	Total
0	22	-	-	-	-	-	-	-	-	-	-	22
5	-	1	2	2	9	9			1	1	1	26
10	-	-	3	-	7	10	5	1	-	-	1	27
15	-	-	4	-	8	21	2	-	-	-	2	37
20	-	-	2	-	6	9	1	-	-	-	-	18
25	-	-	-	-	4	3	-	-	-	-	-	7
30	-	-	-	-	3	3	1	-	-	-	-	7
35	-	-	-	-	6	1	-	-	-	-	-	7
40	-	-	-	-	3	3	1	-	-	-	-	7
45	-	-	-	-	1		-	-	-	-	-	1
50	-	-	-	-	1	1	-	-	-	-	-	2
55	-	-	-	-		1	-	-	-	-	-	1
60	-	-	-	-	1	1	-	-	-	-	-	2
75	-	-	-	-			-	-	-	-	1	1
Total	22	1	11	2	49	62	10	1	1	1	5	**165**

Age-1+	State of Digestion											
Fullness	0	10	20	25	30	40	50	70	80	90	blank	Total
0	6	-	-	-	-	-	-	-	-	-	-	6
5	-	-	-	-	1	6	2	-	2	1	-	12
10	-	-	1	-	4	6	2	-	-	-	-	13
15	-	-	2	1	4	4	2	-	-	-	1	14
20	-	1	2	-	3	5	-	1	-	-	-	12
25	-	1	2	-	4	-	2	-	-	-	-	9
30	-	-	3	-	-	2	1	-	-	-	-	6
35	-	-	1	-	1	1	-	-	-	-	-	3
40	-	-	-	-	-	-	1	-	-	-	-	1
50	-	-	1	-	1	-	-	-	-	-	-	2
55	-	-	1	-	-	-	-	-	-	-	-	1
60	-	-	-	-	-	1	-	-	-	-	-	1
65	-	-	-	-	1	1	-	-	-	-	-	2
70	-	-	1	-	-	-	-	-	-	-	-	1
75	-	1	-	-	-	-	-	-	-	-	-	1
80	-	-	1	-	-	-	-	-	-	-	-	1
Total	6	3	15	1	19	26	10	1	2	1	1	**85**

Table 9. Quantity and percent occurrence of identifiable prey items in age-0+ herring stomachs (N) by location. Table 5 and 6 describe organism abbreviations.

	Fish Egg Inlet		Kwakshua Channel		Powell Anchorage		Kitasu Bay		Spiller Channel		Hunter Channel	
	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence
ALON	1	3.45	70	36	24	19.44	3385	88	1344	68	2096	96
AMPH	16	10.34	-	-	1	2.78	-	-	-	-	76	20
BARNc	7	20.69	166	76	56	58.33	-	-	168	36	482	80
BARNn	4	6.90	1004	84	347	61.11	4	4	1700	88	244	72
CABD	-	-	8	8	2	2.78	733	72	32	12	1190	88
CANG	-	-	11	20	692	77.78	8	4	134	28	140	56
CLAD	22	10.34	2748	88	433	58.33	20	8	7570	96	1800	100
CMAR	-	-	-	-	-	-	-	-	16	4	-	-
CNAU	-	-	-	-	-	-	-	-	48	4	-	-
COPE	-	-	-	-	18	11.11	-	-	36	4	-	-
CRAM	-	-	-	-	149	16.67	-	-	-	-	-	-
CRAZ	1	3.45	16	12	734	41.67	-	-	241	20	8	4
EBUN	4	3.45	-	-	-	-	-	-	-	-	-	-
ECTO	-	-	1	4	23	25.00	-	-	424	64	2	4
EGGS	-	-	15	8	-	-	-	-	340	40	16876	100
EUPA	8	13.79	-	-	-	-	-	-	-	-	-	-
EUPL	-	-	-	-	-	-	-	-	-	-	56	20
GAST	-	-	-	-	-	-	-	-	8	4	8	4
JCAL	1	3.45	284	64	270	55.56	188	36	5140	96	2852	96
LARV	21	6.90	2	4	10	5.56	353	12	96	12	56	16
MPAC	5	3.45	-	-	-	-	-	-	-	-	-	-
MPSE	31	10.34	-	-	2	2.78	-	-	-	-	-	-
OBOR	-	-	-	-	2	2.78	-	-	-	-	16	8
OITH	-	-	-	-	9	8.33	4	4	16	4	64	16

Table 9 continued...

	Fish Egg Inlet		Kwakshua Channel		Powell Anchorage		Kitasu Bay		Spiller Channel		Hunter Channel	
	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence
PELE	-	-	91	52	102	47.22	30	4	336	52	176	44
POLY	-	-	-	-	1	2.78	-	-	8	4	180	36
PPAR	1	3.45	-	-	-	-	68	12	552	44	488	52
PSEU	-	-	-	-	-	-	-	-	-	-	12	8
SHRI	-	-	-	-	5	8.33	-	-	-	-	8	4
TDIS	-	-	-	-	1	2.78	-	-	-	-	-	-
UCAL	12	13.79	802	80	408	66.67	4330	92	7208	92	9454	100
UCYC	1	3.45	28	24	8	13.89	-	-	8	4	-	0
UHAR	1	3.45	2	4	4	8.33	-	-	-	-	24	8
N	29		25		36		25		25		25	

Table 10. Quantity and percent occurrence of identifiable prey items in age-1+ herring stomachs (N) by location. Table 5 and 6 describe organism abbreviations.

	Fish Egg Inlet		Kwakshua Channel		Powell Anchorage		Hunter Channel	
	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence
ALON	-	-	8	4	1	7.14	8	4
AMPH	1	4.76	-	-	4	7.14	67	60
BARNc	-	-	489	96	11	28.57	3	8
BARNn	2	4.76	1031	96	-	-	4	4
CABD	-	-	1	4	-	-	22	40
CALA	81	9.52	-	-	-	-	-	-
CANG	-	-	1	4	149	57.14	1	4
CCOL	-	-	-	-	-	-	2	4
CGRA	4	4.76	-	-	-	-	-	-
CLAD	-	-	3751	96	10	7.14	1	4
CMAR	1	4.76	-	-	-	-	-	-
COPE	-	-	-	-	13	14.29	-	-
CRAM	-	-	2	4	105	42.86	-	-
CRAZ	-	-	34	36	671	100	4	8
DIAT	-	-	85	8	-	-	-	-
EGGS	-	-	-	-	-	-	1	4
ELON	-	-	-	-	1	7.14	-	-
EUPA	70	52.38	-	-	1	7.14	50	52
EUPL	1	4.76	-	-	-	-	1	4
JCAL	-	-	14	12	-	-	7	24
LARV	-	-	2	4	-	-	-	-
MPSE	438	38.10	-	-	-	-	22	32
PELE	-	-	4	8	-	-	-	-
PMIN	-	-	-	-	-	-	1	4

Table 10 continued...

	Fish Egg Inlet		Kwakshua Channel		Powell Anchorage		Hunter Channel	
	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence	Quantity	Percent Occurrence
SHRI	-	-	4	4	12	21.43	-	-
TDIS	-	-	-	-	8	7.14	-	-
UCAL	226	38.10	109	56	17	35.71	13	24
UCYC	-	-	9	16	-	-	-	-
N	21		25		14		25	

Table 11. Herring predator stomach contents from gillnet caught fish. When possible, gut contents were identified to species.

Gillnet Set	Species	Fish	Length (mm)	Weight (g)	Full weight (g)	Empty weight (g)	Content weight (g)	Content	Species Weight (g)	Digestion (%)	Quantity
1	Spiny Dogfish	1	678	1300	71.86	71.85	0.01	shrimp	0.01	25	1
	Spiny Dogfish	2	520	600	50.02	50.02	0	-	-	-	-
	Spiny Dogfish	3	622	1100	100.88	70.3	30.58	fish	9.44	95	2
	Spiny Dogfish	4	590	800	51.97	51.97	0	-	-	-	-
	Spiny Dogfish	5	569	700	51.67	51.67	0	-	-	-	-
	Spiny Dogfish	6	638	1200	172.43	62.56	109.87	eggs	109.87	25	-
	Spiny Dogfish	7	533	500	49.39	49.39	0	-	-	-	-
	Spiny Dogfish	8	527	500	41.82	41.82	0	-	-	-	-
	Spiny Dogfish	9	589	600	71.18	71.18	0	-	-	-	-
	Spiny Dogfish	10	548	500	79.96	48.31	31.65	unknown	-	-	-
	Spiny Dogfish	11	626	800	54.91	54.91	0	-	-	-	-
	Spiny Dogfish	12	608	800	66.45	66.45	0	-	-	-	-
	Spiny Dogfish	13	563	600	48.38	48.38	0	-	-	-	-
	Spiny Dogfish	14	554	600	76.39	51.06	25.33	unknown	-	-	-
2	Spiny Dogfish	1	594	1000	84.09	74.35	9.74	fish	3.5	99	1
	Pink salmon	1	476	1300	10.55	10.55	0	-	-	-	-
	Pink salmon	2	482	1400	15.01	15.01	0	-	-	-	-
	Pink salmon	3	484	1500	12.22	12.22	0	-	-	-	-
	Pink salmon	4	483	1500	8.14	8.14	0	-	-	-	-
	Sockeye salmon	1	549	1800	5.51	5.51	0	-	-	-	-
3	Spiny Dogfish	1	342	100	9.25	9.25	0	-	-	-	-
	Spiny Dogfish	2	861	1200	85.45	85.45	0	-	-	-	-
5	Spiny Dogfish	1	890	2900	139.39	139.39	0	-	-	-	-
	Spiny Dogfish	2	640	1100	112.06	82.58	29.48	squid	29.3	25	1
	Spiny Dogfish	3	777	1800	87.04	87.04	0	-	-	-	-
	Spiny Dogfish	4	458	300	23.26	23.26	0	-	-	-	-
	Spiny Dogfish	5	872	1100	60.12	60.12	0	-	-	-	-

Table 11 continued...

Gillnet Set	Species	Fish	Length (mm)	Weight (g)	Full weight (g)	Empty weight (g)	Content weight (g)	Content	Species Weight (g)	Digestion (%)	Quantity
5	Spiny Dogfish	6	625	900	63.26	63.26	0	-	-	-	-
	Spiny Dogfish	7	580	700	45.98	45.98	0	-			
	Spiny Dogfish	8	800	2100	90.34	86.81	3.53	**herring**	3.53	95	1
	Spiny Dogfish	9	799	2200	102.22	102.22	0	-	-	-	-
	Spiny Dogfish	10	647	1100	65.05	65.05	0	-	-	-	-
	Spiny Dogfish	11	584	700	53.12	53.12	0	-	-	-	-
	Spiny Dogfish	12	591	700	47.34	47.34	0	-	-	-	-
	Spiny Dogfish	13	705	1300	88.76	88.76	0	-	-	-	-
	Spiny Dogfish	14	736	1500	92.91	92.91	0	-	-	-	-
	Spiny Dogfish	15	762	2100	238.25	125.58	112.67	sardine	112.29	5	1
	Spiny Dogfish	16	743	1500	87.54	87.54	0	-	-	-	-
	Spiny Dogfish	17	908	3000	142.57	142.57	0	-	-	-	-
	Spiny Dogfish	18	859	2600	190.87	102.51	88.36	sardine	88.36	5	1
	Spiny Dogfish	19	593	1000	68.74	68.74	0	-	-	-	-
	Spiny Dogfish	20	693	1200	69.15	69.15	0	-	-	-	-
	Spiny Dogfish	21	776	2100	100.74	100.74	0	-	-	-	-
	Spiny Dogfish	22	824	2300	167.22	147.57	19.65	squid	17.28	75	1
	Spiny Dogfish	23	835	2300	118.67	118.67	0	-	-	-	-
	Spiny Dogfish	24	884	2600	168.83	148.92	19.91	fish	18.98	99	-
	Spiny Dogfish	25	856	2800	137.61	137.61	0	-	-	-	-
	Spiny Dogfish	26	752	2000	114.99	114.99	0	-	-	-	-
	Spiny Dogfish	27	652	1000	63.04	63.04	0	-	-	-	-
	Spiny Dogfish	28	537	600	29.43	29.43	0	-	-	-	-
	Spiny Dogfish	29	896	3000	155.09	155.09	0	-	-	-	-
6	Coho salmon	1	369	700	9.09	9.09	0	-	-	-	-
	Spiny Dogfish	1	922	3000	129.14	129.14	0	-	-	-	-
	Spiny Dogfish	2	825	2300	128.79	128.79	0	-	-	-	-
	Spiny Dogfish	3	680	1400	89.56	89.56	0	-	-	-	-

Table 11 continued...

Gillnet Set	Species	Fish	Length (mm)	Weight (g)	Full weight (g)	Empty weight (g)	Content weight (g)	Content	Species Weight (g)	Digestion (%)	Quantity
6	Spiny Dogfish	4	659	1200	82.86	82.86	0	-	-	-	-
	Spiny Dogfish	5	761	1700	107.2	107.2	0	-	-	-	-
7	Coho salmon	1	704	4200	26.92	25.6	1.32	fish	0.82	99	1
	Coho salmon	2	660	4300	39.77	37.13	2.64	fish	2.28	99	1
8	Chinook salmon	1	438	1100	21.05	15.06	5.99	herring	4.66	95	2
	Spiny Dogfish	1	637	1200	100.92	100.92	0	-	-	-	-
	Spiny Dogfish	2	636	1100	110.47	88.33	22.14	fish	19.15	99	
	Spiny Dogfish	3	795	2200	182.07	135.2	46.87	fish	46.87	80	1
	Spiny Dogfish	4	508	500	51.35	51.35	0	-	-	-	-
	Spiny Dogfish	5	526	500	71.46	71.46	0	-	-	-	-
	Spiny Dogfish	6	668	1200	63.79	63.79	0	-	-	-	-
	Spiny Dogfish	7	614	1100	136.53	80.84	55.69	fish	13.78	99	1
	Spiny Dogfish	8	601	900	96.1	96.1	0	-	-	-	-
	Spiny Dogfish	9	675	1100	118.01	63.87	54.14	unknown	31.35	99	
	Spiny Dogfish	10	873	3600	449.9	186.55	263.35	fish	229.55	99	3
	Spiny Dogfish	11	618	800	138.85	74.99	63.86	fish	46.93	99	1
	Spiny Dogfish	12	612	900	85.35	55.81	29.54	fish	25.7	99	
	Spiny Dogfish	13	876	2600	181.58	181.58	0	-	-	-	-
	Spiny Dogfish	14	637	1100	97.86	73.51	24.35	fish	21.49	99	1
	Spiny Dogfish	16	784	2200	368.04	179.95	188.09	fish	188.09	99	1
	Spiny Dogfish	17	514	500	86.08	54.98	31.1	fish	24.58	99	1
	Spiny Dogfish	18	520	600	51.33	47.17	4.16	fish	4.16	99	1
	Spiny Dogfish	19	704	1500	139.89	85.1	54.79	fish	54.79	90	1
	Pacific hake	1	583	900	17.64	9.7	7.94	euphasiids	7.82	5	
9	Coho salmon	1	294	200	11.3	7.76	3.54	fish	3.18	99	2
	Spiny Dogfish	1	791	2400	201.63	144.26	57.37	fish	32.45	99	1

Table 12. Herring predator stomach contents from purse seine caught fish. When possible, gut contents were identified to species.

Set	Species	Fish	Length (mm)	Weight (g)	Full weight (g)	Empty weight (g)	Content weight (g)	Content	Species Weight (g)	Digestion (%)	Quantity
1	Pink salmon	1			11.86	11.86	0	-	-	-	-
3	Spiny Dogfish	1	634	1200	70.66	70.66	0	-	-	-	-
	Spiny Dogfish	2	555	800	68.35	46.67	21.68	**herring**	13.37	90	3
	Spiny Dogfish	3	552	1000	94.78	52.2	42.58	**herring**	16.97	50	2
	Spiny Dogfish	4	560	700	54.46	43.1	14.36	**herring**	14.36	85	-
6	Pink salmon	1	406	1000	7.58	7.58	0	-	-	-	-
7	Spiny Dogfish	1	518	700	66.33	39.25	27.08	squid	25.38	25	2
	Spiny Dogfish	2	512	600	36.55	36.55	0	-	-	-	-
9	Coho salmon	1	295	300	6.89	6.89	0	-	-	-	-
	Coho salmon	2	285	400	6.54	5.35	1.19	fish	0.86	99	1
	Coho salmon	3	243	200	4.44	4.44	0	-	-	-	-
	Coho salmon	4	252	200	8.8	5.39	3.41	**herring**	2.67	75	1
	Coho salmon	5	244	200	5.54	5.54	0	-	-	-	-
	Spiny Dogfish	1		100	8.6	7.65	0.95	euphausiids	-	-	-
13	Coho salmon	1	682	4500	158.64	57.51	101.13	**herring**	100.78	50	3
	Spiny Dogfish	1	700	1400	73.58	73.58	0	-	-	-	-
	Spiny Dogfish	2	862	2700	177.24	149.51	27.73	**herring**	26.99	50	2
	Spiny Dogfish	3	477		33.08	33.08	0	-	-	-	-
	Spiny Dogfish	4	394		17.25	17.25	0	-	-	-	-
	Spiny Dogfish	5	430		16.98	16.98	0	-	-	-	-
	Spiny Dogfish	6	432		23.38	23.38	0	-	-	-	-
	Spiny Dogfish	9	333		6.9	6.9	0	-	-	-	-
14	Spiny Dogfish	1	582	800	45.13	45.13	0	-	-	-	-
17	Coho salmon	1	359	600	10.7	6.31	4.39	fish	4.09	95	2
	Coho salmon	2	378	700	20.52	9.25	11.27	fish	9.62	95	5
	Coho salmon	3	587	2800	33.98	31.8	2.18	fish	2.08	95	1
	Coho salmon	4	690	4400	33.95	33.95	0	-	-	-	-

Table 12 continued...

Set	Species	Fish	Length (mm)	Weight (g)	Full weight (g)	Empty weight (g)	Content weight (g)	Content	Species Weight (g)	Digestion (%)	Quantity
17	Coho salmon	5	782	6500	78.4	71.46	6.94	**herring**	6.25	5	1
23	Pacific hake	1	667	1600	24.72	20.4	4.32	euphasiids	1.72	25	-
24	Spiny Dogfish	1	559	600	63.11	44.19	18.92	fish	17.29	99	-
26	Chinook salmon	1	383	800	31.83	8.03	23.8	**herring**	22.72	75	6
31	Spiny Dogfish	1	625	1200	59.88	59.88	0	-	-	-	-
32	Spiny Dogfish	1	586	800	61.9	61.9	0	-	-	-	-
	Spiny Dogfish	2	602	900	64.64	64.64	0	-	-	-	-
	Spiny Dogfish	3	483	500	37.46	35.51	1.95	euphausiids	-	-	-
99*	Coho salmon	1	676	3400	36.32	29.03	7.29	**herring**	3.15	50	
	Coho salmon	2	690	3900	36.83	32.89	3.94	fish	3.25	99	2
	Coho salmon	3	605	2800	36.85	33.76	3.09	fish	2.27	99	2
	Coho salmon	4	674	3900	53	53	0	-	-	-	-
	Coho salmon	5	671	4000	45.28	40.35	4.93	fish	4.19	95	1
	Coho salmon	6	344	500	9.41	6.97	2.44	fish	2.35	95	1
	Coho salmon	7	340	500	9.91	7.38	2.53	fish	2.35	99	2

* refers to fish caught with no official set location